

Science diplomacy and transboundary water management

The Orontes River case



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Science diplomacy and transboundary water management The Orontes River case

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Foreword

As a specialized agency of the United Nations, UNESCO contributes to the building of peace through education, science, culture, communication and information. The project supported by the Italian Cooperation and the results outlined in this book are fully in line with such an overarching framework. Transboundary water management and any effort towards implementing advanced technologies to this aim are suitable and concrete ways to enhance cooperation and hence contribute to peace-building in one of the most critical parts of the World. As indicated in the title, the book addresses a clear case of Science Diplomacy, acknowledged as one of the most powerful tools in preventing conflicts and promoting peace.

Freshwater scarcity ranks, indeed, among the most urgent environmental challenges that require international cooperation in order to manage an equal and sustainable utilization of shared waters. UNESCO plays a central role in gathering and disseminating information on freshwater at global level. The International Hydrological Programme (IHP) of UNESCO is an intergovernmental program with the mandate to promote science, innovation, policies and the development of capacities related to the management of the hydrological cycle, including its societal component. To this end, IHP (a) mobilizes scientific and innovation networks; (b) strengthens the interface between scientists and decision makers; and (c) develops institutional and human capacities. Currently, in its Eight Phase, IHP focuses on “Water Security: Addressing challenges at the global, regional and local level”. To implement the program, UNESCO-IHP relies on an extensive network of more than 1500 experts drawn from the UNESCO specialized staff based in Paris or field offices, 169 IHP National Committees, the UNESCO-IHE Institute for Water Education in the Netherlands, the World Water Assessment Programme located in Italy, 28 regional and international Category 2 Centers under the auspices of UNESCO and 35 UNESCO Water Chairs.

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تمهيد منظمة اليونسكو

تساهم منظمة اليونسكو بصفقتها منظمة مختصة تابعة للأمم المتحدة بعملية بناء السلام من خلال التعليم والعلوم والثقافة والاتصالات وتبادل المعلومات. حُظِيَ هذا المشروع بدعم إيطالي، حيث بُيِّنت نتائجُه في هذا الكتاب، التي توافقت توافقاً تاماً مع الإطار العام. تُعدُّ مسألة إدارة المياه العابرة للحدود وكل جهد من شأنه المساهمة في تحقيق إرساء دعائم التقنيات المتطورة لهذا الغرض هي الطرق المناسبة والواقعية لتعزيز التعاون، ثم المساهمة في عملية بناء السلام في بقعة هي الأكثر حساسية في العالم.

يُشير عنوان الكتاب إلى تناول قضية دبلوماسية بارزة، عُرفت بكونها من الأدوات الأكثر فاعلية لمنع الصراعات وتعزيز السلام. في الحقيقة، تُشكل مسألة ندرة المياه العذبة إحدى التحديات الأكثر حرجاً، حيث تتطلب تعاوناً دولياً من أجل إدارة وضمان استغلال متساوٍ دائم للمياه المشتركة. تلعب منظمة اليونسكو دوراً محورياً في جمع ونشر المعلومات المتعلقة بالمياه العذبة وعلى الصعيد العالمي. والبرنامج الهيدرولوجي الدولي IHP هو برنامج حكومي دولي تابع لليونسكو يبتنى العمل في البحث والتطوير العلمي والابتكارات العلمية والسياسات وتنمية القدرات المتعلقة بإدارة الموارد المائية بما في ذلك مكوناتها الاجتماعي. وعليه فإن الغاية الأساسية لهذا البرنامج هي ما يلي: (أ) تعبئة الشبكات العلمية والابتكارية (ب) تعزيز الصلة والتفاعل بين العلماء وصانعي القرار (ج) تنمية القدرات المؤسسية والبشرية. والبرنامج حالياً في مرحلته الثامنة، ومن أولوياته أيضاً: التركيز على مشكلات الأمن المائي وذلك عبر مواجهة التحديات وعلى المستويين العالمي والإقليمي والمحلي. ولتنفيذ البرنامج يعتمد UNESCO-IHP على شبكة واسعة من الخبراء يتجاوز عددهم أكثر من 150 خبيراً متخصصاً، وهم ينتمون إلى اليونسكو ومقرها باريس أو من الذين يعملون في المكاتب الميدانية، وعلى 169 لجنة من اللجان الوطنية للبرنامج، ومعهد اليونسكو للتعليم في مجال المياه ومقره هولندا. ويقع مقر البرنامج العالمي لتقييم الموارد المائية في إيطاليا، تصنيف 28 إقليمي ودولي، مركزان تحت إشراف اليونسكو، و 35 كرسيًا ليونسكو المياه

وهنا أودُّ أن أتقدم بالشكر إلى مكتب اليونسكو الإقليمي للعلوم والثقافة في أوروبا، ومقره في البندقية، الذي تعاون مع المؤسسات المشاركة في هذا المشروع، حيث قدم دعمه الذي لا يُقَدَّر بثمن من أجل اخراج هذا الكتاب إلى النور.

C O N T E N T S

Foreword	6
Foreword (<i>Arabic</i>).....	7
Contents	8
Contents (<i>Arabic</i>)	9
Preface by <i>Fadi G. Comair</i> , MENBO and <i>Michael Scoulllos</i> , GWP-Med	11
Preface (<i>Arabic</i>)	15
Introduction by <i>Maurizio Martellini</i> and <i>Roberta Ballabio</i> , ICIS	19
Introduction (<i>Arabic</i>)	23

PART I - Transboundary water resources management and hydro-diplomacy

Orontes hydro-diplomacy: historical overview and Lebanon's transboundary water treaties

<i>Fadi G. Comair and Michael Scoulllos</i>	29
---	----

Turkey's foreign policy orientation in the water context and the Orontes Basin

<i>Aysegul Kibaroglu and Vakur Sumer</i>	57
--	----

Syrian perspective on transboundary water management in the Orontes Basin

<i>Nouar Shamout</i>	79
----------------------------	----

Building efficient models of global governance

<i>Sarah McLaughlin</i>	109
-------------------------------	-----

PART II - New technology tools for water management of the Orontes River Basin

Water resources and security challenges in the Orontes River Basin

<i>Georges Comair, David Eaton and Daene McKinney</i>	125
---	-----

Technical perspective of ICT as a tool for improved responsible management of the Orontes Basin

<i>Simone Sala, Giovanni Formentin and Andrea Porro</i>	139
---	-----

Data analysis and policy development originating from the application of ICT tools for the Orontes Basin

<i>Bianca Dendena and Stefano Bocchi</i>	161
--	-----

Decision support for improvement of the management and cooperation for the Orontes River

<i>Georges Comair, David Maidment and Daene McKinney</i>	185
--	-----

PART III - Lessons learned for future scenarios and challenges beyond the Orontes

<i>Roberta Ballabio</i>	209
-------------------------------	-----

Biographies.....	217
------------------	-----

المحتويات

6	تمهيد منظمة اليونسكو (باللغة الانكليزية)
7	تمهيد منظمة اليونسكو (باللغة العربية)
8	قائمة المحتويات (باللغة الانكليزية)
9	قائمة المحتويات (باللغة العربية)
11	توطئة الجمعية العامة للشبكة المتوسطية لمنظمات الأحواض (MENBO) والشاركة العالمية للمياه منطقة البحر المتوسط (GWP-Med) ، <i>Fadi G. Comair</i> ، <i>Michael Scoullos</i>
15	توطئة (باللغة العربية)
19	مقدمة مركز إنسوبريا للأمن الدولي (ICIS) <i>Roberta</i> ، <i>Maurizio Martellini</i> <i>Ballabio</i>
23	مقدمة (باللغة العربية)
29	الفصل الأول: ادارة الموارد المائية العابرة للحدود المشتركة و الدبلوماسية المائية. 1.1 الدبلوماسية المائية الخاصة بحالة نهر العاصي: لمحة تاريخية ومفاوضات اتفاقيات ا العابرة للحدود اللبنانية، <i>Michael Scoullos</i> ، <i>Fadi G Comair</i>
57	2.1 توجه السياسة التركية الخارجية بشأن المياه وحوض العاصي ، <i>Aysegul Kibaroglu</i> <i>Vakur Sumer</i>
79	3.1 منظور سوريه بشأن إدارة المياه العابرة للحدود لحوض العاصي ، <i>Nouar Shamout</i>
109	4.1 إعداد نماذج فعالة للحوكمة العالمية، <i>Sarah McLaughlin</i> الفصل الثاني: أدوات تكنولوجيا جديدة لإدارة مياه نهر العاصي
125	1.2 الموارد المائية والتحديات الأمنية في حوض نهر العاصي، <i>Georges Comair</i> ، <i>Daene McKinney</i> ، <i>David Eaton</i>
139	2.2 المنظور الفني لتكنولوجيا المعلومات والاتصالات كأداة مسؤولة لحوض العاصي، <i>Andrea Porro</i> ، <i>Giovanni Formentin</i> ، <i>Simone Sala</i>
161	3.2 السياسة وتحليل البيانات الناجمة عن أداة تكنولوجيا المعلومات والاتصالات لحوض العاصي، <i>Bianca Dendena</i> ، <i>Stefano Bocchi</i>
185	4.2 نمذجة الحوض النهري كدعم لاتخاذ القرارات من أجل تحسين الإدارة والتعاون لصالح نهر العاصي، <i>Danae McKinney</i> ، <i>Georges Comair- David Maidment</i>
209	الفصل الثالث: الدرس المُستفاد لمسيناريوهات مستقبلية، <i>Roberta Ballabio</i>
217	السيرة الذاتية

Preface

By FADI G. COMAIR, *MEDITERRANEAN NETWORK OF BASINS ORGANIZATIONS (MENBO)*
AND MICHAEL SCUULLOS, *GLOBAL WATER PARTNERSHIP-MEDITERRANEAN (GWP-MED)*

From the dawn of time, most human activities have relied on water as the vital resource, which is the prerequisite of any form of life and human activities. Nowadays, our social and economic development and our food security depend to a large extent on the availability of this resource in terms of quantity and quality. The Mediterranean Basin in general, and more specifically its south-eastern part, is encountering rapid changes leading to huge water stress and the tiniest percentage of available drinking water per inhabitant in the world. Changes leading to water scarcity include growing population, with rates annually exceeding 2.8%, and excessive water demand for irrigation. Climate change exacerbates water droughts and risks. In this context, the Near East countries are facing extremely serious problems of water shortages with tragic consequences interlinked with a series of complex geopolitical issues. In fact, overall national sovereignty, political, social and economic factors seem to be equally important to the scarcity of water resources, which may influence conflicts and violent clashes (“water riots”).

This is the reason why water and hydro-diplomacy occupy a central space on the diplomatic agenda of the governments in the region, including Lebanon, Syria, Jordan, Palestine, Israel, Egypt and Turkey. Water has thus become a source of cross-border and therefore interstate risk, not only for the major rivers such as the Nile, the Tigris and the Euphrates, but also for other main riverine

systems such as those of the Jordan, the Orontes and the Nahr el Kebir.

Hydro-diplomacy could, from a systematic point of view, be classified as one of the most important branches of Environmental Diplomacy, though in fact it preexisted. Since water has always been, and still is, a critical strategic natural resource with great economic and development potential, the negotiations on sharing water resources and hydro-diplomacy were placed on the mainstream diplomacy “portfolio” as an integral part of security and peace agendas, long before environmental awareness and the ecological crisis introduced “environmental diplomacy” on the international scene.

To guarantee the equitable use of water resources for the population of the countries involved, a major task of hydro-diplomacy is to overcome a number of challenges and critical thresholds by exploring all possible options for consensus building and by using reliable scientific evidence. Such an approach is essential to the effective implementation of the hydro-diplomacy concept in order to secure water for the future generations. This concept has been applied in the Orontes Basin through negotiations between riparian countries (Lebanon and Syria) leading to the 2002 Agreement, which is based on the principles of the 1997 United Nations Convention.

Hydro-diplomacy, as applied in the case of the Orontes, builds partly on traditional bilateral approaches, taking account of power relations, partly on observing International Law and partly on pursuing new methods and tendencies based on the analyses of the actual water needs at national and local level, considering in particular the most vulnerable communities and enhancing prospects for social and economic development. In this respect, hydro-diplomacy contributed to the reduction of injustice and inequities at both transboundary and national levels.

The present publication is based, on one hand, on the results of the ICT project funded by the Italian Development Cooperation (Ministry of Foreign Affairs and International Cooperation) through the University of Insubria, and on the other hand, on the data and accumulated experience of hydro-diplomacy efforts. It thus brings together two approaches: first a crisp analysis of the evolution in addressing the water challenges applying technological tools on basin management, and secondly, a pragmatic one, based on a case study dealing with water resources in the Middle East.

This handbook is the result of the joint collaboration between the following institutions supporting the above-illustrated work process: UNESCO, in close cooperation with the University of Insubria and the University of Milan, GWP-Med (Global Water Partnership – Mediterranean) and MENBO (Mediterranean Network of Basin Organizations), along with the University of Texas at Austin, USA. All the above, have, in one way or another, longstanding experience in dealing with transboundary water issues. UNESCO's efforts to achieve sound water management approaches and peaceful international relations are impressive and reach out to various levels. Among the organizations co-signing this preface, Global Water Partnership, apart from its cooperation in the Orontes River Basin, has performed considerable work in concept development and capacity building (e.g. the publications *International Law Facilitating Transboundary Water Cooperation* and *Effective Water Governance* in the TEC Background Papers, 2013; as well as the co-sponsorship of the postgraduate course on *Law of Transboundary Water Resources* held at the University of Dundee, Scotland). GWP, through GWP-Med, is also actively involved in facilitating transboundary water cooperation in the Mediterranean: major examples include the Drin River, the adjacent Prespa, Ochrid and Skodra Lakes and the Buna/Bojana tributary, as well as contributions to the work carried out for the Sava and Nestos Rivers and various water bodies in North Africa. MENBO is actively working to support the creation and development of Basin Organizations in the Mediterranean in order to strengthen transboundary water cooperation. In addition, MENBO is promoting within its activities the advantages of twinning agreements between south-eastern Mediterranean countries and EU basin organizations as an effective means of disseminating field experience gained in hydro-diplomacy. The Orontes River case provides MENBO with important experience that could be useful in international basin management. Finally, both GWP-Med and MENBO actively promote the implementation of the UN Conventions, the UN 1997 Convention and UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes in Lebanon and the Middle East.

This collective work provides background information as well as relevant and practical aspects that could assist the improved integrated management

of the shared transboundary water resources of the Orontes. It also offers useful input for addressing key questions such as: How to limit the climate change effects on the riparian countries? How to deal with poor hydraulic resources in the region? How to improve access to sufficient quantities of good quality water for vulnerable populations? How to improve water demand? In conclusion, this work facilitates the efforts to chase away the phantom of water riots in the region and assists governments in adopting policies of cooperation and participation in transboundary watercourse management issues.

Conflict and cooperation in the MENA Region frequently co-exist at various scales, from international to national, sub-national or even local, and in different forms, from silent conflicts to armed and violent riots. Water in transboundary basins must provide the means for cooperation, reconciliation and peace between peoples.

A new “Water Culture” must be developed, not as an abstract ideal but as the means to cultivate actual cooperation in the Middle East. Such cooperation should include technical and economic criteria concerning resources availability, current and future needs within the framework of integrated management and equitable sharing. We must give cooperation approach a serious boost if we wish to maintain peace. Learning to share water could encourage the peoples and the riparian countries to understand each other better and will help them to live together in a climate of confidence, respect, solidarity and prosperity.

توطئة الجمعية العامة للشبكة المتوسطة لمنظمات الأحواض (MENBO) والشراكة العالمية للمياه- منطقة البحر المتوسط (GWP-Med)، بقلم : Fadi G. Comair و Michael Scoullis

اعتمدت معظم الأنشطة البشرية على المياه منذ فجر التاريخ، باعتبارها المورد الحيوي الذي يُعدُّ شرطاً أساسياً لديمومة كل أشكال الحياة والأنشطة البشرية. وفي الوقت الحاضر، تعتمد التنمية الاجتماعية والاقتصادية والأمن الغذائي إلى حد كبير على توافر هذه الموارد من حيث كميتها ونوعيتها. ويشهد عموم حوض البحر المتوسط، ولاسيما الجزء الجنوبي الشرقي منه، مواجهة تغيرات سريعة تُحدث إجهاداً مائياً حاداً بما في ذلك نسبة مياه الشرب المتوفرة للفرد الواحد في العالم. وتسببت هذه التغيرات بدورها في ندرة المياه، من بينها نمو السكان وبمعدلات تتجاوز 2.8٪ سنوياً، وكذلك في زيادة الطلب على مياه الري. إضافة إلى ذلك، فإن التغيرات المناخية تُزيد من حدة آثار الجفاف ومخاطره. وفي هذا السياق، فإن بلدان الشرق الأدنى تواجه مشاكل نقص المياه التي تتسم بخطورتها الجدية مع عواقب أساسية مترابطة بسلسلة من القضايا الجيوسياسية المعقدة، وفي الحقيقة، تبدو عوامل السيادة الوطنية الشاملة والعوامل السياسية والاجتماعية والاقتصادية أنها لا تقل أهمية عن ندرة الموارد المائية التي قد تؤثر على الصراعات والصدامات العنيفة (أحداث الشغب بسبب المياه).

وعليه، فهذا هو السبب الذي يجعل من الماء والسياسات المائية أن تشغل حيزاً مركزياً على جدول الأعمال السياسي لحكومات المنطقة، بما فيها، لبنان وسوريه والأردن وفلسطين وإسرائيل ومصر وتركيا. وهكذا أصبحت المياه مصدراً عابراً للحدود فتشكل خطورة على الدول، ليس فقط بالنسبة للأنهار الرئيسية مثل نهر النيل، دجلة والفرات، بل لغيرها من النظم النهرية الرئيسية مثل، الأردن والعاصي وأخيراً النهر الكبير.

ويمكن تصنيف الدبلوماسية أو السياسة المائية، من وجهة نظر منهجية، على أنها، رغم حضورها السابق، واحدة من أهم فروع الدبلوماسية البيئية، لقد كانت المياه دائماً، وما تزال، تُشكل مورداً طبيعياً استراتيجياً حرجاً مع الإمكانيات الاقتصادية والتطور الكبير، وُضعتُ مفاوضات تقاسم الموارد المائية ودبلوماسيتها على مسار دبلوماسية الاتجاه السائد (ملف) باعتبارها جزءاً مكملًا وأساسياً من برنامجي الأمن والسلام، وهذا حدث قبل أن يُبرز الوعي البيئي والأزمات البيئية (الايكولوجية) "الدبلوماسية البيئية" على الساحة الدولية.

لضمان الاستخدام المنصف للموارد المائية لسكان البلدان المعنية، ينبغي للدبلوماسية المائية القيام بواجب مهم، ألا وهو التغلب على عدد من التحديات والعقبات الحرجة وذلك من خلال دراسة جميع الخيارات الممكنة لبناء توافق الآراء وكذلك عبر استخدام أدلة علمية موثوقة بها. ويُعدُّ هذا النهج ضرورياً للتنفيذ الفعال لمفهوم السياسة أو الدبلوماسية المائية من أجل تأمين المياه للأجيال القادمة. ومما يُذكر، أنه تم تطبيق هذا المفهوم في حوض العاصي وذلك من خلال المفاوضات بين البلدان المتشاطئة (لبنان وسوريه) التي أدت إلى اتفاق عام 2002، اتفاق يقوم على مبادئ اتفاقية الأمم المتحدة لعام 1997.

إذا ما أخذنا نموذج الدبلوماسية المائية المطبق في حالة نهر العاصي، فسنراه مستنداً وبشكل

جزئي، على المحاور الآتية: أولاً: على مناهج ثنائية تقليدية، أخذة بعين الاعتبار، علاقات القوة. ثانياً: على مراعاة القانون الدولي. ثالثاً: على اتباع الأساليب والاتجاهات الجديدة استناداً إلى دراسة الاحتياجات المائية الفعلية وعلى الصعيدين الوطني والمحلي، أخذة بعين اعتبارها، تحديدًا، المجتمعات الأكثر ضعفاً وتعزيز آفاق التنمية الاجتماعية والاقتصادية. وفي هذا الصدد، فقد ساهمت الدبلوماسية المائية في الحد من الظلم وعدم المساواة على المستويين الوطني والعابر للحدود المشتركة.

يعتمد هذا الكتاب على محورين، الأول، هو نتائج مشروع تكنولوجيا المعلومات والاتصالات (ICT) ويتمويل ايطالي عبر جامعة إنسوبريا، والثاني، بيانات جهود الدبلوماسية المائية وخبراتها المترجمة. وعليه فإنه يجمع بين نهجين، أولهما: دراسة مقتضبة حول التطور الهادف لمعالجة تحديات المياه وذلك من خلال استخدام الوسائل التكنولوجية في مجال إدارة الحوض المائي. ثانيهما: برنامج عملي، يستند إلى دراسة حالة التعامل مع الموارد المائية في الشرق الأوسط.

هذا الكتاب هو ثمرة التعاون المشترك بين المؤسسات التي دعمت مراحل العمل والتي تم شرحها انفاً، وهي: منظمة اليونسكو، وذلك من خلال تعاونها الوثيق مع جامعة إنسوبريا وجامعة ميلانو والشراسة العالمية للمياه، منطقة البحر المتوسط (GWP-Med) والجمعية العامة للشبكة المتوسطية لمنظمات الأحواض (MENBO)، وكذلك جامعة تكساس في أوستن، الولايات المتحدة الأمريكية.

لقد قطعت جميع تلك الجهات شوطاً طويلاً في التعامل مع قضايا المياه المشتركة وعليه فهي تمتلك خبرة واسعة في هذا المضمار. تقترب جهود اليونسكو من تحقيق إدارة مائية سليمة، فضلاً عن إقامة علاقات دولية سليمة، تتسم بالجودة وقدرتها على بلوغ مستويات متعددة. بالإضافة لدور منظمة الشراكة العالمية للمياه (GWP) العاملة عبر الشراكة العالمية للمياه- منطقة البحر المتوسط، هناك جهات أخرى تعمل بفاعلية وتشارك في تسهيل التعاون في مجال المياه المشتركة في منطقة البحر المتوسط، نذكر أبرزها: adjacent Prespa - Drin، River، وبحيرتا Skodra و Ochrid و رافد Buna/Bojana، فضلاً عن المساهمات المنجزة لصالح نهري Sava و Nestos وكذلك للعديد من المسطحات المائية في جنوب أفريقيا. وقد عملت الجمعية العامة للشبكة المتوسطية لمنظمات الأحواض (MENBO) بنشاط لدعم وتطوير منظمات الأحواض في منطقة البحر المتوسط بهدف تعزيز التعاون في مجال المياه العابرة للحدود.

وبالإضافة إلى هذا، فإن الجمعية العامة للشبكة المتوسطية لمنظمات الأحواض (MENBO) تروج، ضمن نطاق أنشطتها لمزايا اتفاقيات التوأمة بين بلدان جنوب شرق البحر المتوسط ومنظمات أحواض الاتحاد الأوروبي باعتبارها وسيلة فعالة لنشر الخبرة الميدانية المكتسبة في مجال الدبلوماسية المائية. وتوفر حالة نهر العاصي للجمعية العامة للشبكة المتوسطية لمنظمات الأحواض (MENBO) خبرات مهمة والتي لعلها تكون مفيدة في إدارة الأحواض الدولية. وأخيراً، فإن كلا من الشراكة العالمية للمياه-منطقة البحر المتوسط (GWP-Med) والجمعية العامة للشبكة المتوسطية لمنظمات الأحواض (MENBO) تعملان بنشاط على تعزيز تنفيذ اتفاقيات الأمم المتحدة وتشجيعها، كاتفاقية الأمم المتحدة في عام 1997 و اتفاقية اللجنة الاقتصادية لأوروبا بشأن حماية واستخدام المجاري المائية العابرة للحدود والبحيرات الدولية

في لبنان والشرق الأوسط (اتفاقية اليونيسكو).

يُوفر هذا العمل الجماعي المعلومات الأساسية ، فضلاً عن الجوانب ذات الصلة والعملية التي يمكن أن تساعد في تحسين الإدارة المتكاملة للموارد المائية العابرة للحدود المشتركة لنهر العاصي. فهي تمدنا كذلك بمدخل مفيد لمعالجة المسائل الرئيسية، منها على سبيل المثال: كيفية الحد من آثار تغير المناخ على البلدان المتشاطئة؟ كيفية التعامل مع الموارد المائية الفقيرة في المنطقة؟ كيفية تحسين سبل الحصول على كميات كافية من المياه ذات النوعية الجيدة للمجتمعات الفقيرة ؟ كيفية تحسين الطلب على المياه؟ وأخيراً، فإن هذا العمل يسهل الجهود الرامية لمطاردة شبح أعمال شغب المياه في المنطقة ويساعد الحكومات في تبني سياسات التعاون والمشاركة في قضايا إدارة المجرى المائي العابر للحدود المشتركة.

عادة ما يتعاضد الصراع والتعاون في منطقة الشرق الأوسط وعلى صعد مختلفة، منها التي تبدأ من الصعيد الدولي إلى الوطني أو شبه الوطني وحتى المحلي، وبأشكال مختلفة، ومنها تلك التي تبدأ بصراعات صامتة لتتحول إلى مسلحة وأعمال شغب فيما بعد. ويجب أن تُوفر مياه الأحواض المشتركة الوسائل الكفيلة في خلق التعاون والمصالحة والسلام بين الشعوب.

من الضروري، العمل على ارساء مفهوم "ثقافة المياه" وتطويره، ولا ينبغي اعتباره مفهوماً مجرداً ولكن كوسيلة لإشاعة التعاون الحقيقي وتنميته في منطقة الشرق الأوسط. و ينبغي أن يشمل هذا النوع من التعاون المعايير الفنية والاقتصادية المتعلقة بتوفر الموارد، فضلاً عن الاحتياجات الحالية والمستقبلية في إطار الإدارة المتكاملة والتقاسم العادل. كما يقع على عاتقنا تقديم منهج تعاوني ليكون حافزاً وداعماً حقيقياً إذا أردنا الحفاظ على السلام. ولعل تنقيف وإشاعة مفهوم تقاسم المياه يشجع الشعوب والدول المتشاطئة لفهم بعضها البعض بشكل أفضل، وسوف تساعدهم كذلك على العيش معا في مناخ يسوده الثقة والاحترام والتضامن والازدهار.

المنظمات التي شاركت في التوقيع على هذه المقدمة هي الشراكة العالمية للمياه ، بالإضافة إلى تعاونها في حوض نهر العاصي فقد قطعت شوطاً كبيراً ومهماً في تطوير مفهوم التنمية وبناء القدرات (على سبيل المثال، إصدارات القانون الدولي الهادف إلى تسهيل التعاون المائي عبر الحدود، والحوكمة الفعالة للمياه في ورقات المعلومات الأساسية لعام 2013 ، وكذلك المشاركة في رعاية دورة للدراسات العليا في قانون الموارد المائية العابرة للحدود والتي عقدت في جامعة داندي، اسكتلندا).

Introduction

By MAURIZIO MARTELLINI AND ROBERTA BALLABIO, *INSUBRIA CENTER
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The present publication has been produced in the framework of the project *New Technologies (ICT) for an integrated and sustainable management of natural resources in Lebanon* (referred to as “ICT project”) funded by the Italian Development Cooperation (Ministry of Foreign Affairs and International Cooperation).

The project was implemented under the supervision of the Insubria Center on International Security – ICIS and involved different Italian and international stakeholders.

ICIS is a highly specialized Center established in 2007 at the University of Insubria (Italy), focused on international security issues and international cooperation projects and funded by national (Italian Ministry of Foreign Affairs and International Cooperation) and multilateral (EC) stakeholders. Other institutes directly involved in the implementation of the project include the Centro Interuniversitario per la Cooperazione allo Sviluppo Agro-alimentare e Ambientale (CICSAA) based at the University of Milan, the Global Water Partnership-Med (GWP-Med) and the Lebanese Ministry of Energy and Water (MEW). The project’s main objective was to strengthen and develop the adaptation skills of selected stakeholders, such as policy makers, in order to cope with future scenarios linked to the main driving forces that will be operating in the region in the near future, such as demographic growth, pollution and climate change.

Planning capacities are essential for reaching medium- and long-term water and environmental security and for strengthening the sustainable management of natural resources, in particular water resources. The project made use of two main complementary tools, Capacity Building and Information and Communication Technology (ICT), which were chosen taking into account the project sustainability since their use can be maximized also after the conclusion of the project.

Capacity building plays a central role in implementing informed policies, coherent with a sustainable management focused not only on water quantity but also on water quality.

ICT is considered as a key instrument for collecting and elaborating the data necessary to draft different future scenarios and, hence, to structure informed management policies. The use of information systems such as Decision Support Systems (DSS) plays an important role in the development of resilience and adaptation planning capacities.

The target area, chosen in collaboration with the local counterpart, the Lebanese Ministry of Energy and Water, is the transboundary river basin of the Orontes (Nahr al-Assi), which flows through Lebanese, as well as Syrian and Turkish territories where agricultural activities take place. This last component made it possible to consider and analyze the close link between water and food security. The project, given its hydro-diplomacy implications, was conceived as a pilot action, potentially replicable in other areas of Lebanon and in other countries. Water resources are becoming more and more important in terms of geopolitical security, particularly in the Middle East region where they are usually shared and scarce.

As a conclusive outcome, this innovative publication collects the experience and the results stemming from the project and includes also external stakeholders whose contributions and experiences enrich the publication and represent an important added value to understand the complex water dynamics of the river basin.

The work hence builds also on previous researches and publications and includes technical elements of the river basin, negotiation and hydro-diplomacy aspects as well as practical tools that could be useful to improve river basin management and to meet the challenges of sustainability in the water sector.

The publication, in fact, aims to highlight the importance of the interdisciplinary approach necessary for enabling sustainable management of water resources, including different aspects. The historical, geopolitical and legal context are key to understanding the complex dynamics linked to water management while the scientific tools can foster and support the different initiatives aimed at a responsible and shared management of water resources. Science and technology can constitute important elements for facilitating diplomacy and cooperation in sensitive contexts. Scientific aspects do, indeed, have to take geopolitical and diplomatic issues into consideration, and vice versa.

The first part of the publication focuses on the Orontes River as a transboundary water resource bringing together the riparians' perspectives on management and hydro-diplomacy. It starts with a historical overview of the Orontes and Lebanon's transboundary water treaties. Successively it addresses the Turkish foreign policy orientation related to shared water resources, as well as the Syrian point of view on the water management of the Orontes Basin.

The concluding chapter of this first part develops a theoretical model conceived to foster regional coordination and to build efficient governance also in sensitive contexts, challenged by water transboundary issues.

The second part deals with concrete tools such as ICT models, relevant data collection, software and information systems, that can help meet the challenges for sustainable water management. Policies and analyses stemming from ICT tools can support the elaboration of scenarios, making the management more flexible.

The common thread running through this publication is the Orontes Basin. However the lessons learned can be useful in the context of other shared water resources.

The publication includes varied backgrounds, experiences and perspectives and intends to increase awareness, show the importance of an integrated approach for a sustainable water resource management and propose tools and methodologies to foster discussion and improve diplomacy in the water sector. The publication aims to provide an input to the debate and possibly enrich the dialogue, not only from a theoretical point of view, but by analyzing a river basin with a long history of negotiations over its shared waters from which lessons can be drawn for future challenges.

A final note regards the discrepancies the reader may encounter in the various chapters concerning water catchment data, such as length of watercourses or size of the basin. This reflects the diverse software systems used by the authors and the difference in hydro data characterizing the river basin, as well as the level of uncertainty in the available information base. Varied sources but also potentially diverging claims may contribute to these differences. All these elements underline the need for open-minded cooperation, but indicate also the inherent difficulties. Science, technology, improved and shared data and information, as well as joint capacity development can contribute to building trust, which is essential to successful management of shared resources. Ideas and opinions expressed in this publication are those of the authors; they are not necessarily those of the institutions involved.

مقدمة مركز إنسوبريا للأمن الدولي (ICIS)

بقلم: Maurizio Martellini و

Roberta Ballabio

أصدر هذا الكتاب في إطار مشروع تكنولوجيا المعلومات والاتصالات الجديد لتحقيق إدارة كاملة مستدامة للموارد المائية في لبنان (المصطلح عليها باسم ICT مشروع تكنولوجيا المعلومات والاتصالات ويتمويل من الإدارة العامة للتعاون الإنمائي في وزارة الشؤون الخارجية الإيطالية.

نُفِذَ المشروع تحت إشراف مركز إنسوبريا للأمن الدولي (ICIS) وبمشاركة مختصين من الجانب الإيطالي فضلاً عن أصحاب المصالح المعنيين الدوليين .

يتمتع مركز إنسوبريا للأمن الدولي (ICIS) بال تخصصية العالية، أُسِّسَ عام 2007 في جامعة إنسوبريا (إيطاليا)، يُركِّز على قضايا الأمن الدولي ومشاريع التعاون الدولية ويتمويل من وزارة الشؤون الخارجية الإيطالية MFA ومن أصحاب المصالح المتعددين ضمن الاتحاد الأوروبي. ومن الجدير بالذكر، فقد شاركت مؤسسات معنية أخرى مباشرة في تنفيذ هذا المشروع ، بضمنها المركز الجامعي المشترك للتعاون الإنمائي البيئي CICSAA ومقره جامعة ميلانو، وكذلك مؤسسة الشراكة العالمية للمياه حوض البحر الأبيض المتوسط GWP-Med و وزارة الطاقة والمياه اللبنانية. كان هدف المشروع الرئيس تعزيز وتطوير مهارات التكيف لأصحاب المصالح المنتخبين، مثل، واضعي السياسات، وذلك من أجل مواجهة السيناريوهات المستقبلية المرتبطة بالقوى الدافعة الرئيسة التي سوف تعمل في المنطقة في المستقبل القريب، منها على سبيل المثال، النمو السكاني والتلوث والتغيرات المناخية.

إن إمكانية التخطيط أمر أساسي لتحقيق الأمن المائي والبيئي وعلى الأجلين المتوسط والطويل وكذلك لتعزيز الإدارة المستدامة للموارد الطبيعية، لاسيما الموارد المائية. وظَّف المشروع أداتين تكميليتين رئيسيتين، هما، بناء القدرات وتكنولوجيا المعلومات والاتصالات (ICT)، جاء اختيارهما مراعاة لاستدامة المشروع ولأن توظيفهما يمكن له ان يبلغ الاستفادة القصوى حتى بعد الانتهاء من المشروع.

يلعب بناء القدرات دوراً محورياً في تنفيذ السياسات الواعية، المنسجمة مع إدارة مستدامة، التي لا تركز على كمية المياه فحسب بل على نوعية المياه كذلك.

تعدُّ تكنولوجيا المعلومات والاتصالات (ICT) أداة رئيسة لجمع وإعداد البيانات اللازمة لصياغة سيناريوهات مستقبلية مختلفة، ومن ثم، لهيكلة سياسات إدارة واعية. تلعب نظم المعلومات، منها على سبيل المثال، نظم دعم القرار (DSS) تلعب دوراً هاماً في تنمية قدرات التكيف والمرونة.

إن المنطقة المختارة وبالتعاون مع النظير المحلي و وزارة الطاقة والمياه اللبنانية، هي منطقة حوض نهر العاصي العابر للحدود حيث يبدأ رحلته من الأراضي اللبنانية ويجري عبر الأراضي السورية والتركية، ويحتل هذا النهر مكانة مهمة في ممارسة الأنشطة الزراعية، مكانة اتاحت لعقد دراسة وتحليل العلاقة الوثيقة بين مصدر المياه والأمن الغذائي.

لقد أُعدَّ المشروع، بناءً على الآثار المترتبة للسياسات المائية، على أنه مشروع تجريبي قابل للتطبيق ليس في مناطق لبنانية فحسب بل في بلدان أخرى. لقد أصبحت الموارد المائية تشكل أهمية متزايدة من الناحية الأمنية الجيوسياسية، لاسيما في منطقة الشرق الأوسط، وتحديدًا عندما تكون مشتركة وندرة .

خلاصة القول، فإن هذا الكتاب الجديد يجمع الخبرة والنتائج المستخلصة من المشروع، فضلاً عن تطرقه إلى أصحاب المصالح الخارجيين، الذين اغتت خبراتهم ومساهماتهم هذا العمل، حيث تمثل قيمة إضافية هامة تساعد على فهم ديناميات المياه المعقدة لمنطقة الحوض النهري.

وعليه، فإن هذا العمل يعتمد كذلك على البحوث والمنشورات السابقة ويحتوي على العوامل الفنية للحوض النهري والمفاوضات وأوجه السياسات المائية، فضلاً عن الأدوات العملية التي يمكن أن تكون نافعة في تحسين إدارة الحوض النهري ولمواجهة تحديات الاستدامة في قطاع المياه.

تهدف هذه الدراسة في الواقع، إلى تسليط الضوء على أهمية إتباع نهج متعدد التخصصات يفيد في تمكين الإدارة المستدامة للموارد المائية، بما في ذلك الجوانب المختلفة. إن الإطار التاريخي والجيوستراتيجي والقانوني، هي عوامل أساسية لفهم الديناميكيات المعقدة المرتبطة بإدارة المياه، في حين يمكن لوسائل البحث العلمي تعزيز ودعم مختلف المبادرات التي تهدف إلى تحقيق إدارة مسؤولة ومشتركة للموارد المائية. يشكل العلم والتكنولوجيا عنصرين مهمين في تسهيل عمل الدبلوماسية والتعاون في الظروف الحرجة. وفي الواقع، ينبغي للجوانب العلمية، أن تراعي المسائل الجيوسياسية والدبلوماسية، والعكس صحيح.

يركز الفصل الأول من هذا الكتاب على نهر العاصي باعتباره مورداً للمياه العابرة للحدود فهو يجمع سوية وجهات نظر البلدان المتشاطئة المتعلقة بالإدارة والسياسات المائية. مبتدئاً بلمحة تاريخية حول نهر العاصي ثم يتناول الاتفاقيات المائية العابرة للحدود اللبنانية. بعدها يناقش التوجه السياسي الخارجي التركي المتعلق بالموارد المائية المشتركة، فضلاً عن وجهة النظر السورية بشأن إدارة المياه في حوض العاصي.

ويقدم الجزء الأخير من الفصل الأول نموذجاً نظرياً مُعداً لتعزيز التنسيق الإقليمي، وكذلك إقامة إدارة فاعلة في الظروف الحساسة، لمواجهة قضايا المياه العابرة للحدود .

أما الفصل الثاني، فيبحث في الوسائل العملية الملموسة، مثل، نماذج تكنولوجيا المعلومات والاتصالات، جمع البيانات ذات الصلة، نظم البرمجيات والمعلومات، التي يمكنها المساعدة في مواجهة التحديات من أجل الحفاظ على إدارة مستدامة للمياه. كما يمكن للسياسات والتحليلات الناشئة من أدوات تكنولوجيا المعلومات والاتصالات أن تدعم في وضع خطط تجعل الإدارة أكثر مرونة.

إن الخيط المشترك الذي يربط جميع مواضيع هذا الكتاب هو حوض نهر العاصي، حيث الدروس المستخلصة والتطبيقات الفضلى والاعتبارات، يُمكن لها، بالطبع، أن تتوسع لتشمل الموارد المائية المشتركة الأخرى.

يتضمن هذا الكتاب معلومات متنوعة وخبرات ووجهات نظر تهدف إلى زيادة مستوى الوعي، وإبراز أهمية إتباع نهج متكامل للإدارة المستدامة لموارد المياه ، فضلا عن انه يقترح الوسائل والمنهجيات لتشجيع المناقشة وتحسين العمل الدبلوماسي في القطاع المائي. كما ويهدف إلى فتح مدخل للنقاش الذي لعله يسهم في إثراء الحوار، ليس فقط من الناحية النظرية، ولكن عن طريق الوقوف على هذا الحوض النهري بالتحليل والدراسة لتاريخ طويل من المفاوضات حول مياهه المشتركة التي يمكن من خلالها استخلاص الدروس لمواجهة التحديات المستقبلية.



PART I

Transboundary water resources management and hydro-diplomacy

Orontes hydro-diplomacy: historical overview and Lebanon's transboundary water treaties

FADI G. COMAIR AND MICHAEL SCULLOS

1. Introduction and historical background

Forty percent of the world's population is living at the beginning of the 21st century in transboundary river basins (Phillips et al., 2006). Transboundary waters contribute to 50% of the world's available water resources (Phillips et al., 2006; Earle et al., 2010) and their contribution is even greater in water stressed areas. Millions of people in the Middle East still do not have access to sufficient quantities of good quality water as demonstrated by several stress indices, e.g. the "blue water" availability (Falkenmark and Widstrand, 1992; Gleick, 1993; Lawrence et al., 2002; Phillips et al., 2007, 2009). Furthermore, and despite uncertainty regarding the exact magnitude of expected climate changes, the Mediterranean and the Middle East in particular are according to all models among the regions of increased risk of droughts (IPPC, 2007; IPPC-SREX, 2012). It has been widely recognized that water scarcity and drought, exacerbated by climate change, constitute serious threats to water security¹, linked closely

¹ Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability (source: UN-Water, 2013).

to livelihoods, human health, the nexus of food security, energy security and the overall security issues and peace (Ban, 2007; CLICO, 2013). This is even more true for the Middle East - North Africa region with the accumulated and complex security problems and tensions. Therefore, the international basins in the region are considered potential centers of tensions between neighboring states, although we have many indications that support the theory according to which water stress conditions may also induce cooperation between riparians and therefore development of hydro-diplomacy. Essential to remember is that both conflicts and efforts of cooperation and alliances promoted through hydro-diplomacy have long and often turbulent histories behind them, some of which are not included in the memories of the current generation but still influence behavior and decisions acting as historical collective memory. A recent publication (Scoullou, 2014) emphasized that the Mediterranean is not a melting pot: "The process of melting different raw materials results in the creation of a homogeneous fluid. This is not the case in our region. The Mediterranean is a fine mosaic of solid pieces of immense durability: a mosaic of peoples with deep roots, various ethnic and historical backgrounds, and memories imprinted in their DNA; a mosaic of civilizations, religions, ideologies, and philosophies. As in all mosaics, some pieces are damaged or lost and others are replaced by new ones but, despite changes, the centuries-old outline patterns still remain surprisingly visible". This is even more evident in the study area, the Orontes River Basin, and this fact is important to keep in mind when approaching any kind of transboundary negotiations. This is why a first part of this chapter is devoted to reviewing the long amazing history of the Orontes River and the riparian lands.

The Orontes River (*Οροντης* in Greek) was the longest and the "chief" river of ancient Syria and the Levant in general. According to Strabo (64/63 BC) its earlier name was *Typhon*, while it was also referred to as *Axius* and *Draco* (Thurston Peck, 1898) and is known in Arabic and Turkish as *Nahr al-Assi*, or the "rebellious river". Practically, the Orontes was never navigable and of rather limited use for irrigation. However, its importance was always recognized, mainly due to the convenience of its valley for traffic purposes. The Orontes cuts through the Lebanon Mountains and Syria to reach the sea. Because of the

strategic routes in its valley, the river has always been closely linked to trade and to the rich political, military history of the area and was the notorious theater of numerous military campaigns and battles since the Bronze Age. Serious conflicts on the banks of the Orontes River are known from as early as the 15th Dynasty of the Egyptian New Kingdom, when the Egyptian rulers fought against the Hittites and their allies. Throughout the period between c. 1400 and 1300 BC the Egyptian troops under the reigns of Thutmose IV and Amenhotep III lost territory around the river in North Syria, a process that continued until the Egyptian 19th Dynasty when the young Pharaoh Ramses II organized one of the most important military expeditions of the ancient world: the “Kadesh Campaign” against the Hittite King Muwatalli II and his many allies. Five to six thousand chariots and heavy machines were used on both sides (Eggenberger, 1985). Fought on the banks of the Orontes River in spring 1274 BC, this is the earliest recorded battle in history of which many details are known. After the battle of Kadesh, armed conflicts continued for many years with victories and defeats on both sides, until an official Peace Treaty was concluded in 1258 BC between Rhamesses II and Hattusili III (brother of Muwatalli II), the new Hittite King. This Treaty was inscribed on a silver tablet of which a clay copy is preserved at the Istanbul Archaeology Museum, while another version survived on papyrus. As it constitutes the earliest international peace treaty known to historians (Dougherty, 2012), an enlarged copy of the Kadesh Agreement hangs on a wall of the UN Headquarters.

Among other battles connected to the Orontes, worth mentioning is the important Battle of Qarqar fought in 853 BC, when the army of Assyria led by King Shalmaneser III encountered the allied army of twelve Kings led by Hadadeser of Damascus.

The Orontes River is frequently associated with the history of Antioch (Αντιόχεια in Greek), in Antiquity the second most important Greek city of the Eastern Mediterranean after Alexandria. The city was always defined as «Αντιόχεια η επι Ορόντου» (Antioch on the Orontes) built by King Seleucus Nikator, one of Alexander the Great's generals, creator of the Seleucid Empire, and named after his son, prince Antiochos. The city of Seleucia at the mouth of the Orontes River constituted the port of Antioch. In the late Hellenistic

period Antioch was a great cosmopolitan metropolis of more than half a million people and it may be assumed that the impact of their activities on the river's water quality and resources could have been important. The Orontes valley, Seleucia and Antioch came under Roman rule in 63 BC and continued to thrive. Antioch, known in Latin as *Antiochia ad Orontem*, had the status of an "independent" city (*civitas libera*). Many Roman Emperors have visited the city and the surrounding area and have given support to the construction of several of its significant monuments and infrastructures.

In the Hellenistic Period we also find the first personified representation of the Orontes River. Most famous in Antiquity was a sculptural group by the ancient Greek sculptor Eutychides of Sikyon, a pupil of Lysippus. Around 296 BC (according to Pliny) Eutychides had created for Antioch a bronze statue of Tyche, the civic deity of fortune, protector of the city's prosperity, the tutelary spirit of Antioch on the Orontes, representing her in a complex twisted pose seated on a rock with one foot resting on the back of a youth swimming beneath her as personification of the Orontes River. The goddess wears a mural crown in the form of a city fortification wall. The statue was standing in a prominent place next to the Orontes River as an important, artistic treasure, inspiring immense public sentiment, and existed even till the mid of the sixth century AD. It was reproduced in a number of later Hellenistic and Roman copies as well as in a large number of coins. From the early 1st Century BC till the late Roman Period the statue of the Tyche of Antioch with Orontes is a frequent motif on the city's coins (Cimok, 1994). Emperors Justin and Iustinianus struck the last known coin type with this iconography (pentanumium) in AD 526-7. It is widely believed that this magnificent piece of art perished during the sack of Antioch by the Persians/Sassanids in AD 540, probably melted down to use the bronze for coins or weapons (see Figures 1 and 2).

In the medieval period, namely in 637 AD, the famous Battle of the Iron Bridge was fought between the forces of the Eastern Roman/Byzantine Empire (under Emperor Heraclius) and of the Rashidun Caliphate in a location on the Orontes, some 20 km from Antioch (close to modern day Mahruba) near a nine-arch stone bridge from which the battle took its name because its two gates were trimmed with iron blades. The Byzantine Army suffered heavy losses and few days later Antioch was captured. For the next 350 years the



Figure 1: The Tyche of Antioch with personification of the Orontes River at her feet (A Roman marble copy of the Greek bronze original located in the Vatican Museum (Galleria dei Candelabri) © Janmad , CC BY SA, Wikimedia Commons and Antioch, Tyche, river Orontes © Jona Lendering, CC BY NC SA, <http://www.livius.org>



Figure 2: Roman coin depicting the Tyche of Antioch and Orontes © Classical Numismatic Group, CC BY SA, Wikimedia Commons

Orontes became the border line between two hostile empires, the Christian Byzantine Empire and the Muslim Umayyad Dynasty. In 969 AD the area was regained by the Byzantines. In 1084 and for a short period the area was

under the Sultanate of Rum, which was defeated by the Crusaders, again, on the Orontes. In fact, the Iron Bridge spanning the River Orontes was captured by the Crusaders on 20 October 1097 during their march on Antioch. Albert of Aachen noted that at that time a fortification actually existed at the Bridge, specifying that “on each side of the bridge two towers overhung, indestructible by iron and perfectly adapted for defense”.

Today the Orontes River is shared by Lebanon, Syria and Turkey. The sources of the river, the Al-Labweh, Ain Zarka and Daffash springs, are located in the northern Bekaa region of Lebanon at 400 m above sea level. The Orontes defines 31 km of the Syrian-Turkish border and discharges into the Mediterranean Sea in the Turkish Province of Hatay, where its average annual flow potential including its tributaries (Afrin and Karasu) varies between 2.4 and 2.8 billion cubic meters (BCM) (75.7 to 88.3 m³/sec) (ESCWA, 1996; Kibaroglu et al., 2011).

In the Basins at Risk (BAR) project (Yoffe et al., 2003) the Orontes River Basin was identified as “at risk” because ongoing and future large development projects may result in water scarcity conflicts (Homer-Dixon, 1994). Although it has been demonstrated (GWP, 2013) that multilateral International Water Law could serve as a platform for facilitating transboundary cooperation through establishing transparent and predictable rules of engagement despite the fact that the Orontes is shared between three countries, only limited formal bilateral agreements have been signed to date. Before the 2002 Agreement between Lebanon and Syria, the utilization of the Orontes waters in Lebanon was limited to aquacultures and small-scale irrigation from wells connected to the Orontes system in the Kaa region of Lebanon (Comair, 2008). Most of the literature discussing the Orontes River is either too old (Caponera, 1993) and not legally justifiable, it does not include the 1994 Agreement or it only mentions it concluding that allocations do not fully quantify the water rights of Lebanon and Syria. Literature such as Kibaroglu et al. (2011); Phillips et al. (2006, 2007, 2009) claim that Syria was favored by the 2002 Agreement, and conclude that the water allocations were derived by simple negotiation without detailed justification of the quantities received by Lebanon.

The Orontes River was not included in the very comprehensive CLICO Report

(2013) for the Regional Assessment in the Mediterranean, Middle East and Sahel region.

This chapter aims to explain the hydro-political events that occurred in the course of the evolution of the Syrian-Lebanese Agreements, by: (1) analyzing the most recent agreement on the Orontes signed in 2002, (2) showing how the negotiations have been characterized by a change in the relations and power balance between the riparians, (3) comparing it to the 1997 United Nations Convention on the Law of the Non-navigational Uses of International Watercourses (UN, 1997). Therefore, we herewith report and analyze what actually happened in the negotiations by providing new information based on data available to the key actors involved in the 2002 Agreement. Strengths and weaknesses of each agreement are identified to point out the level of coordination between riparian countries, necessarily limited to the period before the Syrian uprising of December 2011.

It may be concluded that the 2002 Agreement was a reasonably equitable one for both countries since the water allocations were based on a study of Lebanese agricultural and potable water demands.

2. Water agreements prior to 1994

Water agreements involving any area of Turkey, Syria or Lebanon date back to the French Mandate over Lebanon and Syria in the early 1920s (Kibaroglu et al., 2011; Caponera, 1993).

The Hatay Region, known in Arabic as *Liva Iskanderoun* and located on the coast north of Latakia, was originally a part of Syria according to the French Mandate for Syria and the Lebanon, a League of Nations mandate founded after the First World War. In 1936 the Turkish Government promoted the issue of Hatay's "re-unification" with Turkey, based on the fact that the area had a large Turkish-speaking community. The French decision to hand the area over to Ankara three years later was considered a violation of the Treaty of Lausanne and the text of the French Mandate, both written in 1923, but the move was defended by France prior to the League of Nations so as to avoid a Turkish attack on Syria. As regards the Orontes River, the "Final Protocol

to Determine Syria - Hatay Border Limitation” of 1939 between Syria and Turkey stated that the Orontes River and its tributaries should form the border between Turkey and Syria and that its water resources be apportioned equally. However, Syria, never accepted the annexation of Hatay and all official Syrian maps continued to include it as part of the country’s national territory. Negotiations between Lebanon and Syria on the Orontes began in 1940. Although the Syrian Governments rarely raised the issue of Hatay openly to avoid conflicts with Turkey, it was not until 1994 that an official agreement was formally signed between the two countries. It is worth noting that all agreements specifically related to the Orontes Basin – also including the latest one – are bilateral, not involving all three riparians, since Syria had refused to include water allocations in the Syrian-Turkish negotiations on the grounds that the Orontes was not an international river, a clear rejection of the border separating Hatay from Syria across which the river flows. None of these agreements established reasonable and equitable water allocation and uses in the basin (Caponera, 1993). In this territorial issue over the Orontes River, Turkey is also identified as the “hegemonic” country despite the fact that it is located downstream.

3. The 1994 Water Agreement between Syria and Lebanon and the 1997 Addendum

On September 30, 1994 the two countries signed the “Agreement on the Distribution of the Orontes River Water Originating in Lebanese Territory” in Damascus. This agreement allocates a fixed amount of 80 million cubic meters per year (MCM/year) to Lebanon if the river flow exceeds 400 MCM/year at the Hermel Bridge gage (Figure 3) and 20% of the annual flow if the discharge volume is less than 400 MCM/year.

The 1994 Agreement addresses the issue of groundwater withdrawals with a provision authorizing pumping from wells drilled before the signature of the 1994 Agreement, but prohibiting new wells. The wells allowed are those located within a 1,500 m radius from the center of the source and 500 m from either river bank (Lebanese Republic and Syrian Arab Republic, 1994).

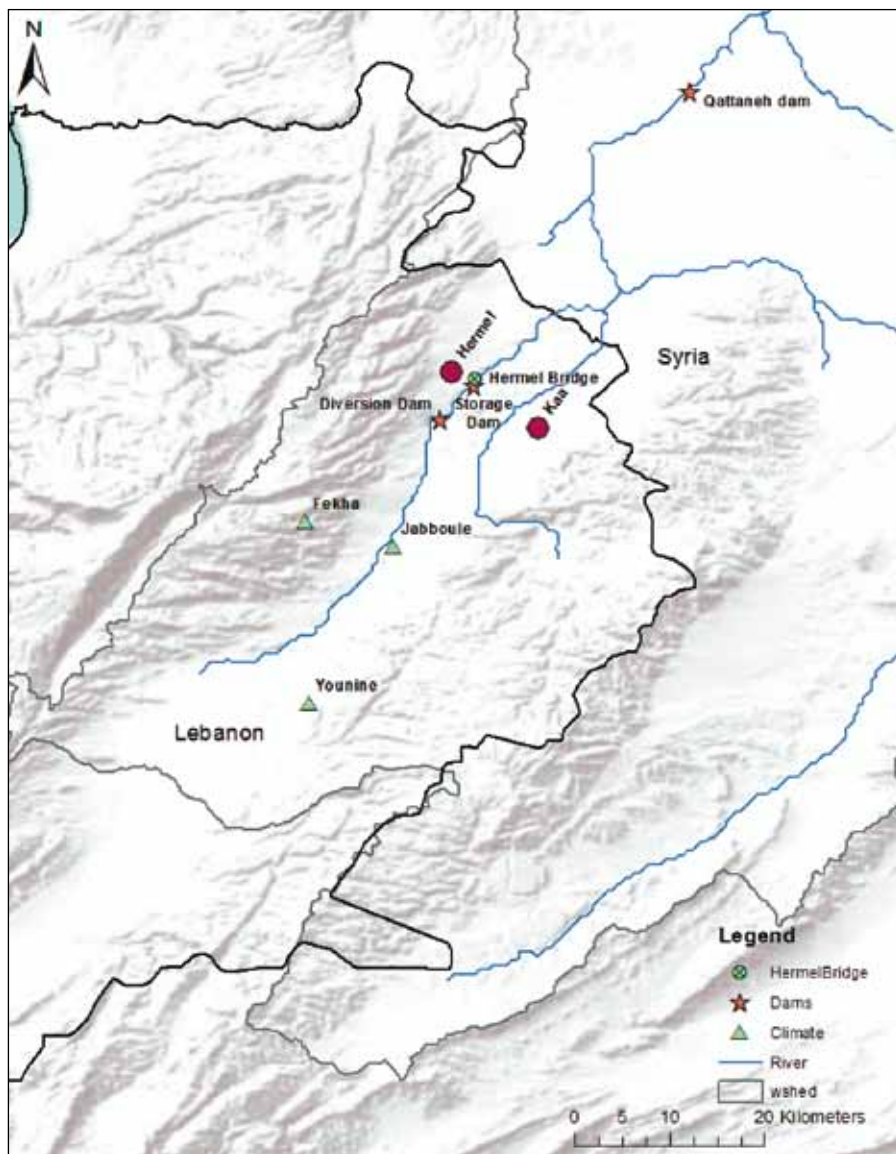


Figure 3: The Orontes Basin near the Syrian-Lebanese border © Fadi G. Comair

The quantities of water allocated to Lebanon will be distributed according to the schedule defined in Table 1.

Month	Lebanese share (MCM)
September-October	10
November-December-January-February	10
March-April	10
May-June-July-August	50
Total	80

Table 1: Water allocated to Lebanon according to the 1994 Agreement

The 1994 Agreement included several weaknesses since it was signed under Syrian influence. In 1994 Lebanon was still recovering from the civil war that ended in 1991 with a cease fire and the entry of Syrian troops in all Lebanese territories. Politically, Lebanon was under strong political and military influence of Syria that impacted all decisions taken by the Lebanese government. Weak areas of this agreement pertained to the field of water resources management, social and economic development and legal aspects. The concept of hydro-hegemony (Zeitoun, 2005) is applicable at the time of signing the 1994 Agreement. The “hegemonic” country – in this case Syria (despite the fact that it is, again, like Turkey, a downstream country in relation to Lebanon) – managed to impose its own water policies on Lebanon. However, Lowi (1993) and Waterbury (1994) argued that no conflict was likely to occur in this region unless it is in the hegemonic country’s interest to enter an open conflict.

In terms of the management of the water resources in the Lebanese part of the basin, future water use necessary to the development of the Kaa and Hermel regions (Figure 3) were not mentioned. One quarter of the water quantities allocated to Lebanon concern the winter season (Sept. to Febr.), outside the irrigation period. In the absence of dams or other regulatory infrastructure, this water, virtually, cannot be used. Storage infrastructure, such as diversion works and accumulation dams, is not mentioned, effectively preventing Lebanon from using its share in spring and summer, when irrigation is needed

for agriculture. Hydrogeological limits of the aquifers are not specified making the study on the impact of wells in the basin (Article 8 of the 1994 Agreement) very difficult to perform.

At the judicial level, the agreement does not comply with an International Water Law framework, such as the 1997 UN Convention, as it does not mention important principles of international transboundary water laws. These include equitable allocation that takes account of: past and existing utilization, economic and social needs of each basin State, as well as the obligation to exchange hydrologic and other watershed information under a Joint Commission especially a joint reporting of the flows (for instance, article 5 does not establish a mechanism for joint management). Obligation of not harming other riparian states (in this case Turkey), was not addressed in the negotiation process.

Finally, the 1994 Agreement may constitute jurisprudence for Israel. This may positively affect the rights of Lebanon to waters in the Hasbani-Wazzani River Basin, a main tributary of the Jordan River. An example of this was the bombing by Israel of the Diversion Dam on the Orontes River during the Lebanese-Israeli war of 2006.

On January 11, 1997, an Addendum was made to the 1994 Agreement which considered the basins of Yammoune, Marjhine, Joubab el Homor and Ouyoun Orghosh as "closed" and not common sources, meaning that they are completely contained within Lebanon and not subject to the transboundary discussions. The Addendum states that the Laboueh tributary waters may be used for irrigation and drinking water purposes from the end of April until October 15 (Lebanese Republic and the Syrian Arab Republic, 1997).

The Minutes of the meetings leading to the agreement were approved in 1997 and contained the following noteworthy points:

1. The utilization of the waters of the "closed" basins of: Yammoune, Marjhine, Joubab el Homor and Orghosh, shall be equal to the quantity of renewable water in these basins.
2. The social conditions of the region of Baalbek-Hermel have been taken into consideration. The Lebanese party may benefit from all the waters deriving from the Laboueh sources during the irrigation season starting by the end of April until October 15, as well as from the drinking waters in use by the neighboring villages.



Figure 4: The Orontes springs of Daffash and Al-Labweh, Lebanon ©Fadi G. Comair



Figure 5: The Orontes River in Hama, Syria © Bernard Gagnon, CC BY SA, Wikimedia Commons

However, the 1997 Addendum still included weak points. As indicated in point 1, the time period over which the quantity of renewable water was calculated was not specified. The positive aspect was mainly point 2 where the poor social conditions of the Baalbek region were considered and additional water could be used by the population in the period April to October for drinking purposes (Figures 4 and 5).

4. The post 1997 negotiations and the 2002 Agreement: a successful example of hydro-diplomacy

The *status quo* in the basin prevailed until 1999, when the Lebanese and Syrian Heads of State decided to review the 1994 Agreement and its Addendum. Due to power asymmetry, this top-down approach decision was the only way to initiate a discussion on hydro-political matters such as water security of the two countries.

Going back to the notion of hydro-hegemony explained earlier, the situation in 1999 proved to be an exception to the rule that usually the hegemonic country plays, always seeking to retain hydro-political power in a transboundary setting. In this particular case the weaker state, Lebanon, was able to leverage benefits in excess of initial basic expectations, as explained by several authors who studied other transboundary basins (Turton, 2003; Daoudy, 2005; Turton and Earle, 2005: 165).

A Lebanese-Syrian High Council of Coordination was formed and met from 1999 to 2002 with the objective of reviewing the 1994 Agreement and its 1997 Addendum in order to make it more equitable and compatible to the 1997 UN Convention which has been ratified by both the Syrian and Lebanese Parliaments.

On the Lebanese side, a Commission of Experts from the Ministry of Energy and Water and consultants was set up in June 1999, to clarify the objectives and investigate the technical, economic and judicial measures required. The result of their work was a list of 10 objectives to be achieved:

1. Rectify the Lebanese situation versus the Syrian position regarding the 1994 Agreement which was considered by the Lebanese side a “lose-win” situation. The objective was to transform this into a “win-win” situation.

2. Convince the Syrian officials that a “win-win” hydro-diplomatic situation between the two riparians will strengthen Lebanon's position regarding possible negotiations with Israel.
3. Build ties between Lebanon and Syria in the hope of establishing a future bilateral agreement between Lebanon and Israel.
4. Enhance the cooperation between the riparians considering the direct and indirect economic benefits arising from such cooperation.
5. Promote social stability through the creation of jobs in agriculture, construction and tourism in the Lebanese districts of Kaa and Hermel.
6. Define the infrastructures needed to utilize the flow allocated to Lebanon in the agreement.
7. Define irrigation schemes for the Kaa and Hermel regions to increase Lebanon's allocated volume for irrigation.
8. Develop hydroelectric power as a cheaper energy resource when compared to groundwater pumping.
9. Improve water quality in the Orontes River Basin especially in Syria and constructing a wastewater treatment plant in Hermel to improve water quality.
10. Establish a database with monitoring measurements of water quantity and quality.

On March 3, 2001, the Lebanese-Syrian High Committee adopted the previously mentioned objectives. The result was that the share of water to Lebanon was fixed at 80 MCM per year plus 16 MCM from wells. An area of 7,000 ha was designated for irrigation in Lebanon, 1,000 ha of which were currently cultivated using groundwater.

The technical and economic studies recommended that the utilization of the Orontes water be planned to cover both banks of the river through the construction of a diversion dam and a pumping station directly after the Ain Zarka and Daffash sources, as well as the construction of a storage dam upstream of the Hermel Bridge. Water stored will be used for drinking, irrigation, and power production (30 MW, 6 hours per day) in dry years. Figure 6 shows the proposed dams, the stream flow gage at Hermel Bridge and includes the new climatic stations that were set up with the support of the ICT Project

in January 2011 to help Lebanon collect the data necessary to implement hydrologic modeling methods, and further implement the provisions of the 10th objective identified above.



Figure 6: The future Orontes River Dam seen from Lebanese side © Fadi G. Comair

An unexpected change in decision making took place in December 2001, typical of the similar situation that occurred, in the Syria-Turkey Euphrates River conflicts of 1975 and 1990 (Kut, 1993). The Syrian side proposed that the negotiated minutes be rejected as they claimed the agreement would create an unstable economic situation and that Syria's river infrastructure was already well established. Since Lebanon is located upstream from Syria, any political conflicts could lead Lebanon to decrease the flow of the Orontes River downstream which could have devastating economic consequences for Syria. The Lebanese delegation at the time responded to this provocation diplomatically by giving a realistic explanation of the unfortunate consequences that Syria could potentially face if it renounces the newly revised agreement, including: negative effects on a major part of the Shiite population in the region, who lives beneath the threshold of poverty and may revolt against Syria; the fact that all the Lebanese communities were in favor of the newly revised agreement; the position of Israel which might see this as an opportunity to impose the same negotiation terms on the Jordan River. The latter could have had the following

consequences: non-restitution of the Golan Heights and non-recovery of the water shares belonging to Syria.

The situation was resolved when the Lebanese and Syrian Presidents met in January of 2002 in Beirut and signed the decision on March 3rd, 2001. This agreement was approved by the Syrian and Lebanese Parliaments in December 2002 and is referred to as the Agreement of 2002. It is comprised of the 1994 Agreement, the 1997 Addendum and the approved Minutes of the Joint Lebanese-Syrian Meetings.

The reason why Lebanon and Syria were able to resolve this potential diplomatic conflict can be explained by the concept of benefit sharing through hydro-diplomacy (Phillips et al., 2006; Comair, 2007). Under hydro-diplomacy, water is used as an element for negotiation and cooperation among countries. Thus, resolving water issues peacefully can directly contribute to increased economic benefits and lead to political stability. Hydro-diplomacy includes the need for a multilateral and multilevel dialogue and the notion of collective responsibility of the international community. It is very important to emphasize the positive role of technical experts/technocrats on both sides in initiating and elaborating a benefit-sharing scenario, where benefits can be generated and shared among the stakeholders of the negotiating riparian countries after all issues have been raised in the negotiation process (Phillips et al., 2006; Tollison and Willett, 1979).

A comparison between the 1997 UN Convention and the 2002 Orontes Agreement is presented in Table 2.

1997 UN Convention	Orontes 2002 Agreement
<p>Article 33: If the Parties concerned cannot reach agreement by negotiation requested by one of them, they may jointly seek the good offices of, or request mediation or conciliation by, a third party, or make use, as appropriate, of any joint watercourse institutions that may have been established by them or agree to submit the dispute to arbitration or to the International Court of Justice.</p>	<p>1994 Agreement, Article 7: A Joint Arbitration Committee shall be constituted by the Technical Committee for the settlement of disputes resulting from the implementation of this Agreement. In case a dispute arises, each party shall submit its point of view to the head of the team representing the Joint Committee.</p>

<p>Article 6: Utilization of an international watercourse in an equitable and reasonable manner taking into account all relevant factors and circumstances, including:</p> <ul style="list-style-type: none"> (a) Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character; (b) The social and economic needs of the watercourse States concerned; (c) The population dependent on the watercourse in each watercourse State; (d) The effects of the use or uses of the watercourses in one watercourse State on other watercourse States; (e) Existing and potential uses of the watercourse; (f) Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect; (g) The availability of alternatives, of comparable value, to a particular planned or existing use. 	<p>Minutes, 27/1/2002: Geographic, hydrographic, hydrological, climatic and ecological factors were taken into account (see “resumption of negotiation” section). The social and economic needs of the watercourse States were considered as well as the population dependent on the watercourse in each watercourse state.</p>
<p>Article 7: Watercourse States shall take all appropriate measures to prevent causing significant harm to other watercourse States.</p>	<p>1994 Agreement, Article 1: Both Parties shall consider the Assi River water streaming from Lebanese territory as of mutual benefit.</p>
<p>Article 9: Watercourse States shall exchange readily available data and information on the condition of the watercourse, in particular that of a hydrological, meteorological, hydrogeological and ecological nature and related to the water quality as well as related forecasts.</p>	<p>1994 Agreement, Article 5: The Joint Technical Committee shall supervise the measurement of the drainage of water as well as the incoming water from rivers, wells, springs and pumps along the river course within the Lebanese territory up to the Syrian border.</p>

<p>Articles 24 and 25: Management, Regulations and Installations.</p> <p>24. Watercourse States shall, at the request of any of them, enter into consultations concerning the management of an international watercourse, which may include the establishment of a joint management mechanism.</p> <p>25. Watercourse States shall cooperate, where appropriate, to respond to needs or opportunities for regulation of the flow of the waters of an international watercourse.</p>	<p>1994 Agreement, Article 5: The Joint Technical Committee shall supervise the measurement of the drainage of water as well as the incoming water from rivers, wells, springs and pumps along the river course within the Lebanese territory up to the Syrian border.</p>
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Table 2: Comparative details of the Orontes Agreement versus the 1997 UN Convention

We can observe that the agreement on the Orontes River, even if it may include minor weaknesses, is fair to Lebanon with regards to economic and social needs as stated in the UN Convention (UN, 1997). Also in terms of water allocations to fulfill urban and agricultural demands the agreement may be considered fair since it was based on a thorough economic and hydrological study of the areas to be served.

The Syrian-Lebanese Agreement is seen as complying with International Law. A negative aspect, the fact that Turkey was not involved in the negotiations is due to the reasons explained earlier in our analysis according to which Syria does not recognize the Turkish rights on the waters of the Orontes related to the controversial issue of the Hatay region. In order for Turkey not to halt the agreement with Lebanon, Turkey and Syria negotiated an agreement of non-involvement by Syria in the Afrin River Basin.

We believe that, under the circumstances, the 2002 Agreement was fair to both Lebanon and Syria and may be considered a win-win outcome. Nevertheless, as mentioned earlier, in any transboundary water agreement there is always room for improvements regarding future adaptation to current transboundary international legislation, e.g. to make it compatible with the UNECE Convention

on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention, 1996). When, hopefully, the political situation in the region will improve, a Regional Basin Organization should be formed that includes all three riparian countries. Water quality assessment of the basin will be most useful for evaluating potentially significant harm factors. In such a case, the upstream country (Lebanon) will have to take measures to prevent deterioration of the water quality flowing into Syrian territory. The same applies to Syria and the potential effects of water pollution on Turkey (downstream country).

It is worth mentioning that, concerning water quality in Lebanon, Law number 337 was issued in March 2002 to reform the water sector towards watershed management and taking into account the general principles of the European Union Water Framework Directive (EU-WFD). The Global Water Partnership – Mediterranean (GWP-Med) and the EU Water Initiative for the Mediterranean (MED-EUWI) have assisted the Government of Lebanon towards such reforms. Furthermore, a water code supported by the French government and the Union for the Mediterranean (UfM) was created to introduce the *polluter pays principle*, take preventive measures to protect aquatic ecosystems and apply legal provisions in case of damage to infrastructure and environmental disaster.

Under changing climatic conditions a considerable decrease of flow in the Orontes may occur, e.g., flow below 400 MCM/year as a common condition. According to the 2009 report on climate change in the Middle East, the International Institute for Sustainable Development (IISD) models predict that by 2050 an increase in temperatures between 2.5 and 3.7 °C is expected in summer and 2.0 to 3.1 °C in winter (IISD, 2009). Precipitation in the Middle East may decrease by up to 50% by the end of the 21st century (Hertig and Jacobeit, 2008). It is obvious that under such conditions, the water regime will be dramatically affected.

Therefore it should be stressed that the agreement did not address climate change and variability thus appearing “non-sustainable and static” against emerging risks. Nevertheless, the existing provision of allocating a share of 20% of the flow to Lebanon if the flow of the Orontes falls below 400 MCM can be effectively met under drought conditions, since it is a proportional

allocation instead of an absolute amount of water in MCM. In any case, it is conventional wisdom that during drought periods, absolute allocations are difficult, if not impossible, to comply with.

5. Conclusion, the current situation and the way forward

Table 3 below summarizes the strengths and weaknesses of the different agreements since the French mandate in the 1920s.

This table provides evidence that all agreements concerning the Orontes Basin so far (up to 2014) are of a bilateral nature. In every single agreement, except for the 2002 Syrian-Lebanese Agreement, power asymmetry in particular is a fundamental aspect of the hydro-political negotiations, for example the first agreements were concluded under the French influence, and the 1994 Agreement was signed under Syrian influence. In each case, the hegemonic country had the political and military power that influenced and dictated the negotiation process, as shown in the “unsettled issues” section of Table 3.

Agreements	Countries involved	Issues discussed/ resolved	Main unsettled issues
1921: Ankara Treaty	Turkey-Syria (French mandate)	Water supply and irrigation for Aleppo’s “water apportionment” is mentioned	Water allocations not explicitly assigned for both countries
1926: Convention of Friendship and Good Neighborly Relations			
1930: Protocol under the League of Nations	Turkey-Syria	Mentions equitable utilization of waters for navigation, fishing, industrial and agricultural uses	Protocol was not implemented. Syria contested the province of Hatay as a Turkish territory

ORONTES HYDRO-DIPLOMACY:
HISTORICAL OVERVIEW AND LEBANON'S TRANSBOUNDARY WATER TREATIES

1939: Final Protocol to Determine the Syria-Hatay Border Delimitation	Turkey-Syria	States that the Orontes River and its tributaries should form the border between Turkey and Syria and that its water resources be apportioned equally	This protocol simply stated the border limitations without legally enforcing it. The Thalweg of the rivers considered to be the border, was still subject to controversy
1991: Fraternity, Cooperation and Coordination Treaty	Syria-Lebanon	Basis for cooperation in the field of water among others. Establishment of the Lebanese-Syrian Joint Committee for Shared Water	
1994: Agreement on the Distribution of the Orontes River Water Originating in Lebanese Territory	Syria-Lebanon	Allocation of 80 MCM/year to Lebanon	No dams or other regulatory infrastructure, and no justification of the 80 MCM allocated
1997: Addendum to the Agreement on the Distribution of Orontes River Water Originating in Lebanese Territory	Syria-Lebanon	Social conditions of poor regions of Lebanon were considered allowing for additional potable water	Quantity of renewable water was not specified
2002	Syria-Lebanon	Share of water to Lebanon was fixed at 80 MCM per year plus 16 MCM from wells. Construction of a diversion dam and a pumping station. Water quality explicitly addressed	Turkey not involved in the negotiations

2004	Turkey-Syria	Start of planning joint dam project	Water allocation and water quality not addressed, no joint contingency plan
2008	Turkey-Syria-Iraq	Joint technical committee formed and agreed to meet once a year and early warning flow measurement systems installed in Syria by Turkey	Water allocation and water quality not addressed
2009: Turkish-Syrian Strategic Cooperation Council Agreement	Turkey-Syria	Memorandum of Understanding concerning the joint dam project	Water allocation and water quality not addressed, no joint contingency plan

Table 3: Strengths and weaknesses of historical agreements showing the coordination levels between states

In many similar international basins of the world, Le Marquant (1990) shows that international law, international posture of each country, linkage between water and other issues and national sovereignty influence transboundary waters. In the case of the Orontes Basin, the last two factors which are linked to international politics and territorial disputes are the most relevant.

Looking at each stakeholder's interest, an analysis of different scenarios ranging from unilateral development to full cooperation should be conducted and can cover all three riparians. For example, Turkey might be primarily interested in flood mitigation plans especially after the collapse of the Zeizoun dam that flooded 1,200 ha of lands in Turkey (Kibaroglu et al., 2011). A future area of cooperation could be the joint implementation of flood mitigation procedures and early warning systems to notify the downstream populations.

It is important to mention at this point that in the period 2000-2002, when the Lebanese-Syrian Agreement was negotiated, the new leadership in Syria and

Turkey started to develop an improved relationship between their countries, signaling that although the Hatay issue had not been solved it was not to stand in the way of prospering bilateral relations. Emma Lundgren Jorum (2014) notes that "the eventual solution was somewhat original... The border was to be blurred and thereby lose its importance. A free trade area was established on the border and a Syria-Turkey Friendship Dam was to be constructed on the Orontes River... Damascus agreed to specify national jurisdiction on both sides of the dam, and thereby, though indirectly, recognized Turkish sovereignty over Hatay". Nevertheless, only weeks after the groundbreaking ceremonies for the construction of the dam held in Hatay and Idlib in February 2011, the Syrian uprising erupted, the bilateral relations reached their worst point and the construction of the Friendship Dam was halted.

In conclusion, the 2002 Lebanon-Syria Agreement reflects the interests of both countries in regulating water flows and increasing storage capacity in the basin to provide sustainable usage. Reconstruction of the diversion dam in Lebanon, destroyed by an Israeli air strike in 2006, has started following a revision of the project costs by the Lebanese Council of Ministers, headed by the Vice Prime Minister and formed in August 2011 for this purpose.

To allow a better management of the basin's water resources a hydrological study has been carried out and geological maps (scale 1:10000) of the Lebanese and Syrian parts of the basin were produced. Additional stratigraphic and structural data in the form of structural geological cross-sections (also at the scale of 1:10,000) were created to help visualize the structural situation in three dimensions. The area from Ain ez Zarqa spring to the Syrian border with Turkey - equivalent to a total length of 600 km - has been examined and mapped. Furthermore, a survey of the Lebanese wells (both legal and illegal) has been completed. From the International Law perspective, the 2002 Agreement is generally based on the principles of the 1997 UN Convention. The successful application of the 1997 UN Convention in the Orontes Basin may promote positive outcomes between nations and guide riparian states to establish common governance frameworks. Syria and Lebanon may, at a given moment, wish to include Turkey in the negotiation process especially in case of a new political landscape in Syria.

Unsettled issues still remain in the Orontes Basin: apart from the water quality

which concerns all riparian countries, water allocation between Syria and Turkey is still an ongoing issue, since the politically unfavorable environment is not only fueled by the Turkish-Syrian disputes over the Hatay province, but also by the Syrian reaction to the Turkish water development projects on the Euphrates River (Phillips et al., 2006).

As to the current situation, due to the prevailing turbulent political conditions in Syria and beyond, the authors note that even if there is always room for further improvement it is neither advisable for a multilateral negotiation nor for Lebanon to re-negotiate the 2002 Agreement with Syria in the foreseeable future. This agreement represents the final decision under the Lebanese government after thorough discussions and additional advice from partner countries (such as the USA and France) and has been welcomed by the United Nations, the European Union and the Union for the Mediterranean forums.

The water volume of 80 MCM/year allocated to Lebanon corresponds to the water needs of Lebanon to irrigate 7,000 ha. Economic analysis pointed out that Lebanon's absolute direct water needs amount to about 7,000 m³ per hectare per year (49 MCM), the remaining 30 MCM/year can therefore be used for potable water.

The above is a concrete example of balancing interests, typical in Integrated Water Resources Management (IWRM) approaches. In general, the application of the IWRM concept is decisive in the fight against water scarcity in the region. The IWRM concept was included in the framework of the Lebanese-Syrian treaty showing that hydro-diplomacy, when applied properly, even in very problematic transboundary basins may catalyze cooperation and good water management while removing or neutralizing sources of conflict. The experience shared between Lebanon and Syria based on the United Nations provisions has strengthened the spirit of mutual compromises in order to maximize water benefits between the two states, which is the heart of hydro-diplomacy. Moreover, based on the above, the two parties have worked together to help developing additional direct and indirect economic benefits in the basin.

The long term sustainable development of the basin cannot be implemented without an adequate governance approach, which should be the next concrete step according to hydro-diplomacy principles, based upon the equitable sharing and reasonable use concept, which requires that the management

of this system shall be exercised in a spirit of participation, responsibility, efficacy and coherence.

The Orontes case, taking into account the long and turbulent history of the region, is undoubtedly a clear demonstration of the opportunities hydro-diplomacy offers in addressing critical water issues in transboundary basins.

References

- Ban Ki Moon (2007). Climate Change Summit.
- Caponera D. (1993). Legal aspects of transboundary river basins in the Middle East: The Al Asi (Orontes), the Jordan and the Nile. *Natural Resources Journal* XLIII(3): 629-663.
- Cimok F. (1994). Antioch of the Orontes, 2nd Edition, Istanbul, Turizim Yayinlari.
- CLICO (2013). Climate Change, Water Conflicts and Human Security. In Regional Assessment and Policy Guidelines for the Mediterranean, Middle East and Sahel, ed. by J. Kloos, N. Gebert, T. Rosenfeld & F. Renaud, United Nations University Institute for Environment and Human Security (UNU-EHS), Report No. 10.
- Comair F. (2007). Transboundary Water Resources: Hydrodiplomacy for Peace in the Middle East, Proc. Environmental and Water Resources Institute Conference, ASCE, Tampa, Florida, May 15-19, 2007.
- Comair F.G. (2008). Gestion Et Hydrodiplomatie De L'eau Au Proche-Orient, Beyrouth, Les Editions L'Orient Du Jour.
- Daoudy M. (2005). Le Partage des Eaux Entre la Syrie, l'Irak et la Turquie: Négociation, Sécurité et Asymétrie des Pouvoirs, CNRS Éditions, Paris.
- Dougherty M.J. (2012). 100 Battles: Decisive Battles that Shaped the World, Parragon: 10-11.
- Earle A., Jägerskog A. and Ojendal J. (2010). Transboundary Water Management: Principles and Practice, 1st ed. Taylor & Francis.
- Eggenberger D. (1985). An Encyclopedia of Battles, Dover Publications: 214.
- ESCWA (Economic and Social Commission for Western Asia) (1996). Water Resources Assessment in the ESCWA Region Using Remote Sensing and GIS Techniques. Report, Beirut, United Nations-Economic and Social Commission for Western Asia, Print.
- Falkenmark M. and Widstrand C. (1992). Population and water resources: a delicate balance. *Population Bulletin* 47(3).
- Gleick P.H. (1993). Water and conflict: fresh water resources and international security. *International Security* 18(1): 99-104.
- GWP (2013). International Law - Facilitating Transboundary Water Cooperation (by P. Wouters), Global Water Partnership Technical Committee (TEC) Background Papers No 17.

- Haddadin M.J., Shamir U. (2002). Jordan Case Study, UNESCO-IHP-WWAP Technical Documents in Hydrology, PC-CP Series No. 15.
- Hertig E. and Jacobeit J. (2008). Assessments of Mediterranean precipitation changes for the 21st century using statistical downscaling techniques. *International Journal of Climatology* 28: 1025-1045.
- Homer-Dixon T.F. (1994). Environmental Scarcities and Violent Conflict: Evidence From Cases. *International Security* 19: 5-40.
- IISD (International Institute for Sustainable Development) (2009). Rising Temperatures, Rising Tensions: Climate Change and the Risk of Violent Conflict in the Middle East. Available at: <http://www.iisd.org/publications/pub.aspx?pno=1130> [accessed 29 October 2012].
- IPPC (2007). Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007, ed. by M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPPC-SREX (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, ed. by C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley, Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.
- Kibaroglu A., Scheumann W. and Kramer A. (2011). Turkey's Water Policy: National Frameworks and International Cooperation, Springer, Berlin.
- Kut G. (1993). Burning Waters: the Hydropolitics of the Euphrates and Tigris. *New Perspectives on Turkey* 9(5).
- Lawrence P., Meigh J. and Sullivan C. (2002). The water poverty index: an international comparison. *Keele Economics Research Papers* 2002/19, Keele University, UK.
- Lebanese Republic and the Syrian Arab Republic (1994). Agreement on the Distribution of the Assi River Water Springing from the Lebanese Territory between the Lebanese Republic and the Syrian Arab Republic. Available at: http://www.syrleb.org/docs/agreements/09ASSI_RIVEReng.pdf
- Lebanese Republic and the Syrian Arab Republic (1997). Annex to the Agreement on the Distribution of the Assi River Water Springing from the Lebanese Territory. Available at: http://www.syrleb.org/docs/agreements/10ASSI_RIVER_ANNEXeng.pdf
- Le Marquant D.G. (1990). International Development of the Senegal River. *Water International* 15(4): 223-230.
- Lowi M. (1993). Water and Power: The Politics of a Scarce Resource in the Jordan River Basin, Cambridge University Press, Cambridge.
- Lundgren Jorum E. (2014). Syria's "Lost Province": The Hatay Question Returns. Available

- at: <http://carnegieendowment.org/syriaincrisis/?fa=54340&reloadFlag=1>
- Phillips D., Attili S., McCaffrey S. and Murray J. (2007). The Jordan River basin: 2. Potential future allocations to the co-riparians. *Water International* 31(5): 39-62.
- Phillips D., Jägerskog A. and Turton A. (2009). The Jordan River basin: 3. Options for satisfying the current and future water demand of the five riparians. *Water International* 34(2): 170-188.
- Phillips D.J.H., Daoudy M., Öjendal J., Turton A. and McCaffrey S. (2006). Transboundary Water Cooperation as a Tool for Conflict Prevention and for Broader Benefit-sharing, Ministry for Foreign Affairs, Stockholm, Sweden.
- Scoullou M. (2014). In Water Scarcity, Security and Democracy: a Mediterranean Mosaic, ed. by F. de Châtel, G. Holst-Warhaft and T. Steenhuis, Global Water Partnership Mediterranean, Cornell University and the Atkinson Center for a Sustainable Future.
- Thurston Peck H. (1898). Harpers Dictionary of Classical Antiquities, New York, Harper and Brothers.
- Tollison R.D. and Willett T.D. (1979). An economic theory of mutually advantageous issue-linkages in international negotiations. *International Organization* 33(4): 425-449.
- Turton A.R. (2003). An introduction to the hydropolitical dynamics of the Orange River Basin. In International Waters in Southern Africa, ed. by M. Nakayama, United Nations University Press, Tokyo: 136-163.
- Turton A.R. and Earle A. (2005). Post-Apartheid institutional development in selected Southern African international river basins. In Water Institutions: Policies, Performance & Prospects, ed. by C. Gopalakrishnan, C. Tortajada and A.K. Biswas, Springer-Verlag, Berlin: 154-173.
- UN (United Nations) (1997). Convention on the law of the non-navigational uses of international watercourses. Adopted by the UN General Assembly, New York.
- UN (2013). UN-Water Analytical Brief on Water Security and the Global Water Agenda. Available at: http://www.zaragoza.es/ciudad/medioambiente/onu/en/detallePer_Onu?id=634
- Waterbury J. (1994). Transboundary water and the challenge of international cooperation in the Middle East. In Water in the Arab World, Perspectives and Prognoses, ed. by Rogers and Lydon, Division of Applied Sciences, Harvard University: 39-64.
- Water Convention (1996). UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes.
- Yoffe S., Wolf A.T. and Giordano M. (2003). Conflict and Cooperation Over International Freshwater Resources: Indicators of Basins at Risk. *Journal of the American Water Resources Association (JAWRA)* 39(5): 1109-1126.
- Zeitoun M. (2005). Hydro-hegemony theory - a framework for analysis of water related conflicts. First International Workshop on Hydro-hegemony, King's College, London, 21-22 May 2005.

Turkey's foreign policy orientation in the water context and the Orontes Basin

AYSEGUL KIBAROGLU AND VAKUR SUMER

1. Introduction

This chapter will basically aim at understanding, explaining and analyzing the foreign policy orientation of Turkey in the transboundary waters context. Turkey's state practices include a rich history of treaty practices, as well as political statements and actions which culminated in regional water governance trends displaying consensus, but in most cases disagreements. The chapter will analyze how harmonization with the European Union (EU) has had impacts on the transboundary water policy discourses and practices in Turkey, and how these changes have been reflected in the country's relations with its neighbors in the Middle East. The Orontes River Basin is presented as a case-study with its geographical features and hydro-political history. In this context, transboundary water politics in the Orontes will be examined with its entrenched complexities. The chapter will focus on the divergent views of Syria and Turkey over the Orontes, the cooperation initiatives taken in the last decade, specifically the proposed "Friendship Dam" project which came to a standstill after the civil war in Syria and consequent deterioration of relations between Turkey and Syria. The chapter will also briefly present the need for a reappraisal of the transboundary water management practices in the basin so that they would favor greater participation of stakeholders which have traditionally been excluded in the region, such as women.

2. Turkish foreign policy and water

Turkey's water policy aims at achieving a number of fundamental objectives, such as increasing agricultural production and food security; meeting the increasing demand for drinking water in rural and urban areas as well as in the industrial sector; decreasing dependency on imported energy sources; diminishing the regional, economic and social discrepancies in the country; and increasing the welfare of the society. Transboundary water policies have been formulated at the national level in conformity with these strategic objectives. According to the Turkish Ministry of Foreign Affairs, which carries the primary responsibility for formulation as well as implementation of transboundary water policy, Turkey's policy regarding the use of transboundary rivers is based on the following principles (Ministry of Forestry and Water Affairs, 2013):

- "Water is a basic human need.
- Transboundary rivers are elements of cooperation rather than a reason for conflict.
- Each riparian state of a transboundary river system has the sovereign right to make use of the water in its territory.
- Riparian states must make sure that their utilization of such waters does not give significant harm to others.
- Transboundary waters should be used in an equitable, reasonable and optimum manner.
- Equitable use does not mean the equal distribution of waters of a transboundary river among riparian states.
- The objective of transboundary water cooperation should be sharing the benefits of transboundary waters.
- Transboundary water disputes should be settled between the riparians and mediation attempts of third parties should not be supported.
- Transboundary water use and allocation should be conducted with a consideration of natural hydrological and meteorological conditions.

Accordingly, the risks of droughts should be shared between the co-riparians. Under such variable hydrological and climatic conditions, water sharing cannot be settled on the basis of fixed numbers or quantities.

- Turkey is ready to share its experiences, technology and human resources capacity with its neighbors in building hydroelectric power stations, dams and other water infrastructure including irrigation and drinking water systems.”

and for the Euphrates and Tigris Rivers in particular:

- “The two rivers constitute a single basin.
- The combined water potential of the Euphrates and the Tigris Rivers is, in the view of the Turkish authorities, sufficient to meet the needs of the three riparians provided that water is used in an efficient way and the benefit is maximized through new irrigation technologies and the principle of “more crop per drop” at basin level.
- The variable natural hydrological and meteorological conditions must be taken into account in the allocation of the waters of the Euphrates and the Tigris Rivers.
- The principle of sharing the benefits at basin level should be pursued.
- Turkey is ready to negotiate all aspects of the Euphrates and Tigris waters. In this context, as a token of goodwill, Turkey is providing data and information to the neighboring countries upon their request. Yet, data exchange should be carried out mutually and at the basin level.”

According to the Ministry of Forestry and Water Affairs, Turkey's transboundary water policy is furthermore formulated by taking into consideration the priorities of the country with respect to its economic and social development needs, as well as the framework of the accession negotiations with the European Union (EU) (Ministry of Forestry and Water Affairs, 2013).

Water has become an issue in Turkish foreign policy in the 1980s with the planning and building of a series of large-scale dams and giant irrigation projects in the Euphrates-Tigris River Basin within the context of the Southeastern Anatolia Development Project, also known as the GAP project, with a view to achieving social and economic development in the country. History and geography, the main factors that determine a country's foreign policy, have played a key role in the formulation of the transboundary water policy. In this context, since the first years of the Republic the state of affairs in the relations with the neighboring states has determined the main framework for transboundary water policy. On the other hand, the Cold War period,

which influenced Turkey's regional and bilateral relations with its neighbors, has also directly affected its transboundary water policies. In that period, the damaging impact of the Cold War has played a negative role in failing to develop fruitful relations with Syria, Iraq and Bulgaria over the waters of the Orontes, Euphrates-Tigris, and Meric/Maritsa Rivers, respectively.

Nevertheless, since the early years of the Republic, Turkey has adopted a foreign policy of developing institutional structures with its neighbors by conducting negotiations, signing treaties and establishing temporary or permanent technical committees, using the instruments of diplomacy and international law. For instance, the Arpacay Dam jointly constructed with Armenia, the 1987 Protocol signed with Syria as an (interim) agreement for sharing the waters of the Euphrates River and a series of protocols and agreements signed with Bulgaria – all of which were in the “enemy” camp during the Cold War period – bear witness to Turkey's determination to adopt a peaceful approach in the disputes with its neighbors over the transboundary water resources as envisaged in the United Nations Charter as well as in customary law.

The geographical characteristics of Turkey have played a key role in defining its transboundary water policy. In Turkey, the tributaries of the Meric/Maritsa, Coruh, Orontes, Euphrates-Tigris and Aras Rivers are classified as transboundary waters or waters which constitute boundaries.¹ The drainage basins of these rivers have a total extension of 256,000 km², representing one third of Turkey's total surface area. The average water potential of these rivers inside Turkey is 70 billion cubic meters per year, which is equivalent to 30% of the overall water potential of the country. Turkey occupies the upstream position on the Euphrates-Tigris, Coruh and Aras Rivers, and the downstream position on the Meric/Maritsa and Orontes Rivers. It has land borders of 2,753 km length with its neighbors, namely Greece, Bulgaria, Georgia, Armenia, Azerbaijan, Iran, Iraq and Syria, and the above-mentioned rivers represent 22% of these borders. Transboundary rivers constitute 30% of Turkey's fresh water resources.

¹ Rivers that originate from the territory of a sovereign country and flow into the territory of other countries by crossing the borders are categorized as transboundary rivers, whereas rivers that flow along the borders of two or more countries and thus constitute the border between these countries are categorized as international rivers.

Moreover, Turkey's arable and irrigable lands are located in these river basins, for instance the Euphrates-Tigris River Basin covers 20% of Turkey's irrigable lands. Hence, taking into consideration the conditions of the urban and rural population in these basins as well as the population growth and the increasing living standards, geographical factors clearly stand out in the formulation of the transboundary water policies.

2.1 Institutional development in transboundary water policy-making

The fundamental foreign policy principles regarding transboundary water resources have been established and bureaucratically institutionalized in Turkey – especially since the 1980s – within the framework of the conditions shaped by the physical as well as human geography under the influence of the global, regional and bilateral relations that evolved in the second half of the 20th century. In addition to the direct role played by considerations of national political and economic interests, the formulation of these principles was influenced by international water law and international politics.

With the increasing impact of the GAP (Southeastern Anatolia Project) in the international arena, a bureaucratic structure has evolved since the 1980s where the principles and policies with regard to the transboundary waters have been determined. A department in charge of regional and transboundary waters which is responsible for issues pertaining to energy, water and the environment has been formed within the Ministry of Foreign Affairs, under the Directorate General. Moreover, relevant state institutions, providing ample technical information, such as the status of water resources in terms of quality and quantity, as well as institutions responsible for the development, management and preservation of water resources are expected to work in conjunction with the Foreign Ministry in the formulation of the fundamental principles of foreign (water) policy. First and foremost among these institutions is the State Hydraulic Works (Turkish acronym, DSI), which is responsible for the development and administration of Turkey's water resources since 1954. The DSI has accomplished a series of projects for energy, drinking water, irrigation, flood control and drought management especially in the GAP region. Its mandate included the collection of data pertaining to the quality and the quantity of the surface and groundwater resources in 25 river basins

in Turkey, as well as the planning, implementation and management of the projects aiming at meeting the water demand for drinking usage, and for use in agriculture, industry, energy and related sectors. As such, it has provided important inputs to the Ministry of Foreign Affairs in the formulation of the principles of transboundary water policy, despite the fact that its tasks have recently been partially taken over by the private sector, stakeholders (irrigation associations) and other state institutions.

On the other hand, a development agency, namely the Southeastern Anatolia Project Regional Development Administration (GAP RDA), which is responsible for the coordination and for the effective and equitable implementation of socio-economic development projects in the GAP region, initiated transboundary cooperation in the field of water based development, which paved the way for new openings in transboundary water policy. Hence, in 2001, a Joint Communiqué was signed between the GAP RDA under the Prime Ministry of Turkey and the General Organization for Land Development (GOLD) under the Syrian Ministry of Irrigation.² The GAP RDA-GOLD cooperation is based on the common understanding of the sustainable use of the region's land and water resources through joint rural development and environmental protection projects, joint training programs, exchanges of experts and technology and study missions. In the course of 2001 and 2002, Syrian and Turkish delegations visited each other's development project sites. During these contacts the two sides had opportunities to exchange experience of positive and negative impacts of water and land resource development projects dating back several decades. Once again, the water issue was relegated to the technical level, as in the 1960s, and left to intergovernmental networks composed of technocrats. However, unlike the technical negotiations in the 1960s, the GAP-GOLD dialogue covered such disparate issues as urban and rural water quality management, rural development, participatory irrigation management and agricultural research. Even though the dialogue between these two leading institutions has

² A joint Communiqué between the Republic of Turkey, Prime Ministry, Southeastern Anatolia Project Regional Development Administration (GAP) and the Arab Republic of Syria, Ministry of Irrigation, General Organization for Land Development, 23 August 2001, Ankara, Turkey (file in possession of the authors).

not resulted in concrete project implementation or regular exchange programs, it has served as a semi-formal consultation mechanism and paved the way for initiatives taken by other government departments and agencies in 2008 and 2009 with the similar objective of solving transboundary water problems within a broader framework of political, economic and social development.

Turkey's water policies towards its neighbors, namely Europe, the Middle East and the Caucasus, and its regional role have been changing considerably. Among these, evolving relations with the European Union (EU) within the framework of ongoing accession negotiations have significantly transformed the Turkish water sector. The goal of EU accession implies that Turkey is obliged to adopt and implement the entire body of European Environmental Law, covering many far reaching legal requirements (for example, the Water Framework Directive with significant implications for the member states' international water cooperation) as well as a couple of international environmental agreements where the EU is the contracting party. In the EU-Turkey accession partnership, the transboundary water issue has already been identified as a priority issue in a series of *Progress Reports* issued by the European Commission. In this perspective, Turkey has adopted a number of laws and by-laws on environmental protection and water quality management in the domestic, agricultural and industrial sectors since the mid-2000s. This legal reorientation has been basically guided by the European Union's water legislation within the framework of the accession process.

Hence, since the beginning of Turkey's candidacy for EU membership in the early 2000s, the Ministry of the Environment and Forestry (MoEF)³ has taken initiatives to pass the necessary legislation with a view to striking a balance between the use and the protection of water resources, thus contributing to the formulation of transboundary water policies. The new approaches developed by the Ministry of the Environment and Forestry within the framework of the relations with the European Union have played a key role in the Memoranda of Understandings (MoU) signed with Syria and Iraq in 2009 regarding the use, development and protection of water resources (Kibaroglu and Scheumann, 2013).

³ In June 2011, the MoEF was reorganised taking the name of Ministry of Forestry and Water Affairs. See: <http://www.ormansu.gov.tr>.

The concepts used in these MoUs, such as “river basin level water management”, “establishing emission standards”, “polluter-pays” and “cost-recovery principles” reflect the terminology employed in the EU Water Framework Directive (2000), the legal document constituting the basis for the EU water policies. Therefore, the MoEF staff in particular vigorously sustained these protocols because they felt that these would be useful in supporting the implementation and extension of the new water legislation in Turkey in the transposition process of the EU water legislation⁴. The EU’s water management approach which is formulated at the “river basin level” in its Water Framework Directive of 2000 will not only be applied in Turkey’s national river basins but also in its transboundary river basins such as the Euphrates-Tigris and Orontes. Moreover, common standards for measuring water quantity (gauging) and monitoring transboundary water quality are among MoEF’s main objectives in its cooperation with Syria and Iraq. In this context, one of the main aims of the Turkish bureaucracy has been to establish environmental quality standards and to implement the polluter-pays and cost-recovery principles at transboundary level, as stipulated in the relevant MoU⁵.

In the same manner, relevant ministries directly responsible for the technical aspects of the issue have been involved in the formulation of transboundary water policies, in addition to the Ministry of Foreign Affairs, one of the primary actors in the country’s policy-making. This is a dramatically different approach than the one adopted in the negotiations pursued with Syria and Iraq in the Euphrates-Tigris River Basin since the 1980s. Unlike the agenda of the diplomatic negotiations in the past, this approach focuses on the use and management of the water resources without necessarily mentioning the sharing and allocation of water resources.

⁴ Since the mid 2000s Turkey adopted a number of laws and by-laws on environmental protection and water quality management in the domestic, agricultural and industrial sectors. This legal reorientation has been basically guided by the European Union’s water legislation within the framework of the accession process.

⁵ The Memorandum of Understanding (MoU) between the Government of the Republic of Turkey and the Government of the Syrian Arab Republic in the Field of Remediation of Water Quality, 23 December 2009.

3. The Orontes River Basin

3.1 Geographic and hydrologic features

The Orontes River rises in the karstic springs of Al-Labweh, Ain Zarka and Daffash in the northern Bekaa region of Lebanon near the city of Baalbek at an altitude of 690 m. Also known as *Asi Nehri* in Turkish and *Nahr-al Asi* in Arabic, the Orontes is the only river in Western Asia that flows north and drains west into the Mediterranean (UN-ESCWA and BGR, 2013). The Orontes enters the Syrian territory near the Lebanese town of Hermel, it then passes through the cities of Homs and Hamah, crosses the fertile Al-Ghab region where intensive irrigation systems have been established, and defines 56 km of the Syrian-Turkish border (Korkmaz and Karatas, 2009: 21)⁶ before entering into Turkey. The river turns southwest in Turkey, passing through Antakya and discharging into the Mediterranean Sea near Samandag in the Turkish province of Hatay.

The data concerning total length and catchment area of the Orontes River vary according to the different sources. Most of the sources mention a length between 448 and 571 km. A recent study using Google Earth images at an altitude of 2,000 m calculated a total length of 556 km, of which 40 km lie in Lebanon, 366 km in Syria and 98 km in Turkey (Korkmaz and Karatas, 2009: 21).⁷ While data on the catchment area fluctuate between 17,000 km² and 37,900 km², Korkmaz and Karatas (2009), using Arc Map v. 9.2, calculated the actual catchment area of the Orontes as 21,743 km². According to this study, 26% of the catchment area is situated in Turkey, 67% in Syria and 7% in Lebanon.⁸ The Orontes has two main tributaries: the Afrin River, which has a larger water

⁶ 25 km, according to UN-ECSWA and BGR (2013: 228), and 32 km according to Caponera (1993: 630).

⁷ These figures are contested by several other studies including UN-ECSWA and BGR, which report that the total length of the river system is 404 km. Bazza and Najib (2003: 7), on the other hand, argues that the total length is 485 km, of which 336 km in Syria.

⁸ According to UN-ECSWA and BGR (2013: 224), based on the study by Lehner et al. (2008) on topography and stream network of the Orontes drainage area, the catchment covers an area of 26,530 km², shared by Syria, Turkey and Lebanon respectively by 67%, 25%, and 8%. Aquastat and FAO, on the other hand, refer to a catchment area of 24,660 km² (69% in Syria, 23% in Turkey, 8% in Lebanon) (Aquastat, 2008: 1).

flow, and the Karasu River. The Afrin River originates in the Turkish Kartal Mountains, it flows south through the city of Afrin in Syria and then re-enters Turkey, draining into the Amik Lake. The Karasu River runs almost entirely through Turkey except forming a small section of the Turkish-Syrian border. The combined mean annual discharge potential of the Orontes River including its tributaries is estimated at 2.4 to 2.8 billion cubic meters (BCM), representing a flow of 75.7-88.3 m³ per second (Comair et al., 2013).⁹ The mean annual flow volume measured near Hermel in Lebanon is 0.41 BCM. At Syria's Al-Omeiry station close to the Lebanese border, however, the mean annual flow volume decreases to 0.2 BCM, indicating the intensive water use for irrigation in the region concerned (UN-ESCWA and BGR, 2013: 231). The average yearly flow potential at the point of entry into Turkey is estimated at 1.4 BCM for the Orontes, 0.6 BCM for the Afrin and 0.4 BCM for the Karasu (Scheumann et al., 2011: 303). However, during summer months the Orontes dries up before reaching Turkey due to extensive water use in Syria's Al-Ghab region (Baran et al., 2006: 576).

The Orontes system is mainly fed by groundwater (around 90%) which is dependent upon the snow cover in the Lebanon and Anti-Lebanon Mountains (UN-ESCWA and BGR, 2013: 231). Spring snowmelt constitutes the peak flow in the system. Groundwater discharge due to snowmelt continues to maintain river flow during dry summer seasons. Another period of high river flow appears during the winter months due to increased rainfall. As a result of Mediterranean climate characteristics, the Orontes River Basin annually receives 400-500 mm of rainfall most of which occurring during winter season.

3.2 Water development and use by the riparians

While the water resources of the Orontes River and its tributaries are intensively used by all riparians for irrigation purposes and for domestic and industrial water uses, the irrigation by Syria and Turkey constitutes by far the greatest usage, of which the demand occasionally exceeds the supply of the river system. In 2009, FAO estimated the total irrigated area in the basin at

⁹ An earlier study by DSI gives an annual discharge of 3.4 BCM (DSI, 1958: 24). Therefore, the annual water potential of the Orontes river system dropped considerably in the last several decades.

300,000 to 350,000 ha, of which 58% situated in Syria, 36% in Turkey and 6% in Lebanon. Beside the issue of quantity, one of the prominent concerns over the Orontes waters is the water quality caused by polluting discharges in the Syrian part of the basin creating significant problems in downstream Turkey. This section elaborates the current status of water development and use in the Orontes Basin.

3.2.1 Upstream (Lebanon)

Despite the fact that the headwaters of the Orontes are located within Lebanese territory, the utilization of its water resources in Lebanon is hitherto mostly confined to small-scale farming, fish farms and tourism activities (UN-ESCWA and BGR, 2013: 234), with an annual total use of 21 million cubic meters (MCM). The bilateral water-sharing agreement on the Orontes River, signed in 1994 between Lebanon and Syria, stipulates that Lebanon's annual share amounts to 80 MCM, out of 420 (or 510) MCM.¹⁰ While the agricultural sector is the largest consumer of water, accounting for 77% of the total use, domestic water use amounts to 23%.

According to FAO estimates, 18,000-21,000 ha are irrigated in the Lebanese part of the Orontes Basin. These figures are to be increased when the Assi irrigation scheme will be operational. The Assi scheme project is divided into two phases and includes two dams with a total capacity of 64 MCM, as well as a number of pumping stations and irrigation networks which will irrigate an additional 6,800 ha in the Hermel and Al Qaa regions. The Assi scheme also aims at creating 50 MW of hydroelectricity and providing water for domestic use in Baalbek and Hermel.

The water quality in the Lebanese part of the Orontes is relatively good, given the low level of pollutants originating from agricultural, industrial or domestic water use.

3.2.2 Midstream (Syria)

Syria is the major user of the Orontes water resources, accounting for 90%

¹⁰ The FAO Aquastat Database estimates surface water flow to Syria at 510 MCM/year through the Orontes River and the bordering El Kebir River (FAO Aquastat, 2008).

of the annual flow which amounts to 1.2 BCM at the Syrian-Turkish border (Aquastat, 2008: 4).

Unlike the rest of the country, harnessing the water of the Orontes started during the French Mandate (1930s). In 1937, reconstruction of the ancient Qattineh Dam was initiated in order to regulate the flow and increase the irrigation capacity of the Orontes (Aquastat, 2008: 3). In terms of water use, the Orontes River constitutes the second most important river in Syria after the Euphrates, providing 20% of the country's total estimated water use volume. Agriculture is the largest water user, consuming about 1,977 MCM/year (77% of total water use), followed by domestic water use at 9% and industry at 8%. Average annual groundwater use for irrigation (1,111 MCM or 56%) exceeded surface water use (886 MCM or 44%) during the period between 1992 and 2009.

Since the 1950s Syria has intensively developed water resources in the Orontes Basin. First large dams in Syria were constructed on the Orontes, at Rastan and Mhardeh in 1960 (Aquastat, 2008: 3). This was further accelerated with Decree No. 3 of 1972, which initiated the construction of multipurpose dams. Over the years Syria has built 41 dams in the basin (Aquastat, 2008: 3). The total reservoir capacity of all dams in the basin reached about 950 MCM in 2006. The Rastan, Qattineh, Zeita and Mhardeh Dams have the largest storage capacity.

Two main agricultural areas in Syria are supplied with water from the Orontes: the region between Homs and Hama and the Al-Ghab region. The latter was systematically drained from the 1950s onwards to reclaim land for irrigated agriculture. The Orontes riverbed was enlarged and deepened, and dams were built to regulate the flow of the river and to provide water for irrigation. The Al-Ghab Project was carried out between 1958 and 1967 and covered 46,000 ha. An area of about 70,000 ha is now being irrigated as part of this project, consuming around 330 MCM/year of reservoir water and another 150 MCM/year of groundwater. The region between Homs and Hama, on the other hand, is partly supplied from the Qattineh Lake via the Homs-Hama canal, providing water to an area of about 23,000 ha. Since the reservoir does not meet the demand, it is supplemented by groundwater wells, which irrigate another 20,000 ha in this part of the basin. The total irrigated area in the Orontes Basin in Syria has increased from approximately 155,000 ha in 1989

(Aquastat, 2008: 3), to 200,000 ha in 1992 and 215,000 ha in 2008 (Aquastat, 2008: 3), while occasionally exceeding 250,000 ha in the period between 2004 and 2008. On average, an area of about 97,000 ha (43%) is irrigated by surface water and 130,000 ha (57%) by groundwater. Part of the groundwater used is derived from fossil aquifers. The extent of the pressure on these resources, particularly in the Ghab region, puts the sustainability of water resources in the whole Orontes River Basin at risk (Hamade and Tabet, 2013: 56). Another region which significantly increased the use of groundwater for irrigation purposes is the Province of Idlib (Aquastat, 2008: 3).

The intensification of water use in the Orontes Basin in Syria has raised the question of long-term water sustainability. Water tables in some parts of the western Orontes Basin have dropped as much as 57 m in 10 years (FAO, 2003: 342). The total irrigation water need in the Syrian part of the Orontes Basin is indicated in the amount of 3,586 BCM (Wakil, 1993: 20), a number well above the annual discharge capacity of the Orontes.

The Orontes Basin is considered one of the country's most disturbed hydrological ecosystems. Apart from agriculture-based nitrate and phosphate pollution, industrial wastewater is discharged into the streams with limited or no treatment. Water quality is also threatened by domestic wastewater discharge in many parts of the basin (UN-ESCWA and BGR, 2013: 236-237).

3.2.3 Downstream (Turkey)

The Orontes river system constitutes the main watercourse of the Hatay and Kilis provinces in the Eastern Mediterranean region of Turkey. The Amik Plain in the Hatay province is a significant agricultural area in the Turkish part of the basin.

Because of the frequent flooding of towns and villages in the Amik Plain due to insufficient natural drainage canals, the authorities decided to drain the Amik Lake in the early 1940s. Draining of the Lake by the State Hydraulic Works of Turkey (DSI, Turkish acronym) started in the 1950s and was completed in the early 1970s. Hence, the Amik Plain became an important agricultural area of the Eastern Mediterranean region of Turkey, covering an area of 31,000 ha. However, flooding and increased soil salinity - negatively affecting agricultural productivity - have become two major concerns in the area due to problems

in the drainage works, particularly those executed in the 1970s (Kibaroglu et al., 2005: 69).

The most noteworthy dams in the Turkish part of the Orontes Basin are the Yarseli and Tahtakopru Dams, both located on tributaries of the Orontes. There are also two water development projects under construction and six in the investigation phase. These projects are designed to regulate the flow of the river system in order to provide water for irrigation and domestic use, to generate hydropower and to protect lands and settlements from floods (Kibaroglu et al., 2005: 69).

Irrigated agriculture in the Turkish part of the basin covers, according to the Turkish Ministry of Agriculture and Rural Affairs (2004: 116), an area of more than 125,000 ha. Based on DSI exploratory surveys, the total area that can be irrigated by the Orontes river system within Turkey is estimated around 225,000 ha (DSI, 1958).

3.3 Transboundary water issues: claims - counter claims, negotiations and treaties

There are a number of bilateral water agreements involving Turkey, Syria or Lebanon, the earliest of which date back to the French mandate (over Lebanon and Syria) in the early 1920s. The issue of supplying water for irrigation is the biggest priority in the basin as reflected in the agreements. However, to date, there is no agreement involving all three riparians.

3.3.1 Syria-Lebanon

Negotiations between Lebanon and Syria on the Orontes began as early as 1940. In 1962 a Syrian-Lebanese joint committee was established to deal with the Orontes, allocating an annual water amount of 100 MCM to the Hermel and Ka'a regions in Lebanon. In 1968, the committee decided to re-consider the annual water needs of both countries. Syria and Lebanon decided in 1972 to allocate 80 MCM/year to Lebanon, but this agreement never became operative (Comair et al., 2013: 134; Salha, 1995: 25-30).

Finally, on 20 September 1994 the two countries signed the "Bilateral Agreement Concerning the Usage and Sharing of the Waters of the Al-Asi River (Orontes) between the Syrian Arab Republic and the Lebanese Republic" which formally

allocated 80 MCM/year to Lebanon and 340 MCM/year to Syria. In case of a fall in annual discharge of the Orontes below 400 MCM/year, Lebanon's share would be proportionately reduced. The management of the headspring and river flow was settled in the agreement and a technical committee composed of experts from both countries was formed in order to control and manage the Orontes headwaters in the Lebanese part of the river basin. The works, however, were to be financed solely by Syria. In this agreement the Orontes water resources are considered "common waters" (Canatan, 2003: 82).

Downstream Turkey was totally excluded from this agreement leading to criticism among the Turkish bureaucracy and the general public. Turkey was neither notified nor consulted in the negotiation process (Salha, 1995). On the implementation level the agreement does not truly comply with the international water law framework, namely the basic principles of the 1997 UN Watercourses Convention, even though it refers to the customary water law principles in its wording.

3.3.2 Syria-Turkey

So far, conflicts over the use of the Orontes' waters occurred mainly between Turkey (downstream) and Syria (midstream). From the Turkish point of view, problems are caused by agricultural water demand and planned irrigation projects in both countries as well as by the quality parameters of the water when entering Turkey. Syria, for long, did not recognize Hatay as Turkish territory and thus rejected any discussions over Orontes waters.¹¹ For Syria, the concern is rather to control the headwaters of the Orontes River in Lebanon which appears to be one of the factors that contributed to the lengthy Syrian military involvement in Lebanon. Within this context, Syria always demanded that the Orontes headwaters should stay in Lebanese territory and not be given to Israel (Kolars et al., 1986: 262).

Several agreements between Turkey and the French mandate over Syria during the 1920s and 1930s included clauses relating to the Orontes water resources (Caponera, 1993: 634-635). The first agreement between independent riparians

¹¹ Negotiations on the Friendship Dam implied Syria's unofficial yet effective recognition of Turkish sovereignty over Hatay (Jörum, 2014).

was the “Final Protocol to Determine Syria - Hatay Border Limitation” signed between Syria and Turkey in 1939, which stipulated that the waters of the rivers (i.e. Orontes, Karasu and Afrin), where they constitute the boundary between Syria and Turkey, will be utilized in an equal manner. There were, however, no further stipulations on how to use the rivers’ water resources.

In 1950, Syria approached the World Bank to receive funding for the Al-Ghab Project. An agreement was signed between the two parties in the same year. Taking account of the Turkish concerns, the World Bank convened a meeting between Turkish and Syrian experts in Damascus, Syria. Findings of these experts were summarized in an official Turkish letter to the World Bank concluding that Turkish territory would face frequent floods during the period of construction, and that the project would leave no water for Turkey during irrigation seasons (Caponera, 1993: 633).

In 1952 Syria and Turkey reached an agreement on the Jaghjagh and Baligh (Balik) Rivers, two rivers flowing from Turkey to Syria. However, this agreement was not ratified by the Turkish Parliament because of the concerns over Syrian plans for the Orontes and the actual use of the Afrin River by Syria. The Turkish aim was to include all rivers shared with Syria not just those flowing *from* and *into* Syria (Hirsch, 1956: 215). In 1962, Syria assigned the development of the Orontes River project to the Dutch company NEDECO. As noted by Caponera (1993: 634), this plan focused solely on the projects in Syria without mentioning the “requirements, interests and acquired rights of Turkey”. In response to this plan, the Turkish delegation, during a meeting involving experts from both riparian countries, proposed the adoption of a draft protocol calling for a river basin development plan concerning the whole basin in order to determine measures to mitigate flood hazards, to study the feasibility of constructing a dam at the border to irrigate the Amik Plain, and to install early warning systems for flood protection. This proposal was not welcomed by the Syrian delegation, and no agreement was reached at the meeting (Kibaroglu et al., 2005: 69-70; Caponera, 1993: 634).

From 1983 onwards, water related talks between Syria and Turkey continued mainly under the mandate of a Joint Technical Committee. It soon became evident that negotiations between Turkey and Syria appeared to be more difficult than relations between Syria and Lebanon. One of the reasons for this

is related to conflicting views on the subject of negotiations. While Syria was persistently rejecting to discuss the Orontes waters with Turkey on the grounds of territorial claims to the Hatay province and the Orontes as a national river, Turkey demanded a framework for discussion taking account of all regional transboundary waters (including the Euphrates and Tigris).

Since 1995, Turkey's complaints as to the quantity of water entering Turkey became vociferous. According to the Turkish Ministry of Foreign Affairs the water quantity was reduced from 1.55 BCM to 140 MCM. Syria, on the other hand, advocated that the reduction in the amount of water released to Turkey was predominantly caused by the drought conditions, not by an increase in Syrian use (Shapland, 1997: 146).

A change of tide occurred when in October 1998 the two countries signed the Adana Security Protocol, followed by reciprocal visits of the Syrian President to Turkey and the Turkish Prime Minister to Syria, as well as by the signing of the first Free Trade Agreement on 22 December 2004.

4. The Orontes Friendship Dam: the Orontes from a “bone of contention” to a “medium of cooperation”

In the same year, during the visit of the Turkish Prime Minister Erdogan to Damascus in 2004, Turkey advanced the proposal for the construction of a joint “Friendship Dam” on the Orontes. Both sides agreed in principle to proceed with this project (Soylemez, 2005) and after a series of technical studies on topographic and geological characteristics of the region, a number of sites for construction of the dam were identified (Scheumann et al., 2011: 309).

Finally, on 23-24 December 2009, Turkey and Syria agreed to start the construction of the Friendship Dam on the Orontes River at the Turkish-Syrian border. The agreement was reached at the first meeting of the High-Level Strategic Cooperation Council in Damascus, which also resulted in the signing of 50 Memoranda of Understandings, four of which related to water issues.

The dam is expected to be approximately 15 m high with a capacity of 110 MCM. 40 MCM of this capacity will be used for flood protection while the rest will be

utilized for energy production and irrigation. Costs of construction were to be shared between the two riparians. It was also decided that both countries would install and operate flow measuring stations in the area serving as early warning systems for flood protection. The foundation of the dam was laid on February 7, 2011. The initial plan was to finish the main body of the dam in one year, and the hydroelectric plant and irrigation systems in two years (Hurriyet, 2011), but the outbreak of internal unrest in Syria followed by the deterioration in Turkish-Syrian relations caused the project to be suspended.

Notwithstanding the fact that the completion of the dam will take some years due to the internal situation in Syria, the signing of an official protocol on the Orontes waters was a real breakthrough in Turkish-Syrian hydro-politics and also in broader political relations. For decades, Syria did not recognize the Turkish-Syrian political border crossed by the Orontes, maintaining territorial claims to the Turkish province of Hatay (historically known as Alexandretta). The signing of the protocol implied the recognition of the border by Syria. Also, for decades, Turkey had demanded regulation of the water flow of the Orontes River which had often been fluctuating, causing severe floods and droughts in downstream towns and villages in Turkey. Yet, Syria never agreed to build water development structures at the border, arguing that the Orontes is a national river. In this respect, the Protocol of December 2009 marks a drastic change in Syria's attitude. In fact, there can be flourishing cooperation between otherwise hostile riparian states after their agreement to build joint dams on common borders.¹²

5. Conclusion

This chapter first analyzed how Turkey's transboundary water policy is founded on its officially declared basic principles. Turkey's transboundary water policy is formulated in accordance with national socio-economic development goals and determined by its specific geographical and historical

¹² The Arpacay Dam between Turkey and Armenia (former USSR) built in the 1970s, and the Lesotho Highlands Project between South Africa and Lesotho constitute two examples of such endeavors.

context. The transboundary water policy has been mainly planned and implemented by governmental institutions, in particular the Ministry of Foreign Affairs (MoFA), specifically with the initiation of the GAP project in the early 1980s. Other concerned ministries and non-governmental institutions have attempted to provide technical and intellectual input to the policy formulation. Transformation of the water bureaucracy had also an impact on the foreign policy initiatives such as the signing of the bilateral Memoranda of Understandings with Syria and Iraq by the keen initiatives of the Ministry of Environment and Forestry. All in all, the MoFA has articulated the main principles of the transboundary water policies, some of which highly inspired by customary international law and treaty practice.

In the second part, transboundary water issues in the Orontes River Basin are presented with its geographical and hydrological features. Water development and use by the riparians are explained by highlighting the fact that irrigation is the major competitive user in the basin while there is still potential to develop the river basin by constructing multi-purpose dams such as the attempted Friendship Dam on the Turkish-Syrian border, yet halted due to the internal conflict in Syria. This part also discussed transboundary water politics in the region by delineating negotiation processes and treaties, mainly taking place at bilateral levels (Syria-Lebanon and Syria-Turkey).

It has been demonstrated in this chapter that, despite the existence of a number of cooperative initiatives between countries of the basin, a tri-partite cooperative framework is lacking. Furthermore, prevailing cooperation attempts in the river basin need to be more inclusive in terms of different segments of society. In particular, women, who play crucial roles in water management practices, should be incorporated in cooperative arrangements among riparians.

The internal conflict in Syria, which erupted in spring 2011, had devastating impacts on water use and management in the Orontes Basin. Today, the Orontes Basin comprises some of the most conflict-affected areas in Syria. Springs, wells and water networks are strategic for territorial control by either pro-regime or opposition forces, and have been deliberately targeted to interrupt water supply in certain sectors. Two-thirds of the four million inhabitants of the basin have been displaced over the past three years (Jaubert, 2014: 6).

This chapter is not intended to analyze the implications of ongoing conflict on water use and management in Syria. However, our study and observations bring us to the conclusion that transboundary water cooperation will be essential to respond to the urgent needs of communities in Syria. From a post-conflict perspective, rehabilitation of the domestic and agricultural water infrastructure will be a priority to ensure the sustainable return of displaced populations. Beyond emergency relief interventions, the prioritization and allocation of resources for reconstruction will be determinant factors in the reconciliation process. Hence, in these processes, co-riparians, namely Turkey and Lebanon may play critical and constructive roles for recovery in the Syrian water sector as well as maintaining water and food security.

References

- Aquastat (2008). Irrigation in the Middle East Region in figures, Aquastat Survey 2008: Asi-Orontes River Basin.
- Baran T., Ozis U. and Ozdemir Y. (2006). Sınır Asan Asi Havzasi Su Potansiyeli Ve Yararlanilmasi. TMMOB Su Politikalari Kongresi, 21-23 March, Ankara: 571-581.
- Bazza M. and Najib R. (2003). Towards Improved Water Demand Management in Agriculture in the Syrian Arab Republic, First National Symposium on Management and Rationalization of Water Resources Use in Agriculture, Damascus, FAO.
- Canatan E. (2003). Turkiye-Suriye Arasinda Asi Nehri Uyumazligi, Master's thesis, Hacettepe University, Ankara.
- Caponera D. (1993). Legal aspects of transboundary river basins in the Middle East: The Al Asi (Orontes), the Jordan and the Nile. *Natural Resources Journal* 28(3): 629-663.
- Comair G.F., McKinney D.C., Scoullous M.J., Flinker R.H., Espinoza G.E. (2013). Transboundary cooperation in international basins: Clarification and experiences from the Orontes river basin agreement: Part 1. *Environmental Science and Policy* 31: 133-140.
- DSI (1958). Asi Havzasi istikşaf Raporu (The Exploratory Report on the Orontes Basin), Devlet Su Isleri, Etud Plan Dairesi, Ankara.
- FAO (2003). Syrian Agriculture at the Crossroads, FAO Agricultural Policy and Economic Development Series.
- Hamade S. and Tabet C. (2013). The Impacts of Climate Change and Human Activities on Water Resources Availability in the Orontes Watershed: Case of the Ghab Region in Syria. *Journal of Water Sustainability* 3(1) March: 45-59.

- Hirsch A.M. (1956). From the Indus to Jordan: Characteristics of Middle East International River Disputes. *Political Science Quarterly* 71(2): 203-222.
- Hurriyet (7 February 2011). Available at: <http://www.hurriyet.com.tr/ekonomi/16953457.asp> [accessed 15 April 2014].
- Jaubert R. (2014). Syria: The impact of conflict on population displacement, water and agriculture in the Orontes river basin, Water Security in the Middle East, Swiss Agency for Development and Cooperation, Geneva.
- Jörum E.L. (2014). Syria's 'Lost Province': The Hatay Question Returns. Available at: <http://carnegieendowment.org/syriaincrisis/?fa=54340> [accessed 11 April 2014].
- Kibaroglu A, Klaphake A., Kramer A., Scheumann W., Carius A. (2005). Cooperation on Turkey's Transboundary Waters, Research report for the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety, Adelphi Research, Berlin.
- Kibaroglu A. and Scheumann W. (2013). Evolution of Transboundary Politics in the Euphrates-Tigris River System: New Perspectives and Political Challenges. *Global Governance* 19: 279-305.
- Kolars J., Naff T., McCaffrey S.C., Dellapenna J.W. (1986). Hydro-Geographic Background to the Utilization of International Rivers in the Middle East, Proceedings of the Annual Meeting (American Society of International Law) 80(9-12) April: 250-267.
- Korkmaz H. and Karatas A. (2009). Asi Nehri'nde Su Yönetimi ve Ortaya Çıkan Sorunlar (Water Management in the Orontes and Emerging Problems). *Mustafa Kemal Üniversitesi, Sosyal Bilimler Enstitüsü Dergisi (Mustafa Kemal University Journal of Social Sciences Institute)* 6(12): 18-40.
- Ministry of Forestry and Water Affairs (2013). Havza Yönetimi ve Su Bilgi Sistemi Çalışma Grubu Raporu, Ormancılık ve Su Surası 21-23 Mart 2013, Ankara: 33-34.
- Salha S. (1995). Türkiye, Suriye ve Lübnan İlişkilerinde Asi Nehri Sorunu (The Orontes River Problem in Relations Between Turkey, Syria and Lebanon), Dis Politika Enstitüsü Yayınları & Hacettepe Üniversitesi, Ankara, 55 pp.
- Scheumann W., Sagsen I., Tereci E. (2011). Orontes River Basin: Downstream Challenges and Prospects for Cooperation. In *Turkey's Water Policy: National Frameworks and International Cooperation*, ed. by A. Kibaroglu et al., Springer-Verlag, Berlin.
- Shapland G. (1997). Rivers of Discord International Water Disputes in the Middle East, St. Martin's Press, New York.
- Soylemez Y. (2005). Prime Minister Erdogan's Return Visit to Syria. *Hurriyet Daily News* 2 January 2005. Available at: <http://www.hurriyetdailynews.com/default.aspx?pageid=438&n=prime-minister-erdogan8217s-return-visit-to-syria-2005-01-02> [accessed 21 April 2014].
- Turkish Ministry of Agriculture and Rural Affairs – Hatay Provincial Directorate of Agriculture and Rural Affairs (2004). Hatay İli Tarımsal Master Planı (Agricultural Master Plan for Hatay Province).

- UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe) (2013). Inventory of Shared Water Resources in Western Asia, Beirut.
- Wakil M. (1993). Analysis of Future Water Needs for Different Sectors in Syria. *Water International* 18(1): 18-22.

Syrian perspective on transboundary water management in the Orontes Basin

NOUAR SHAMOUT

1. Introduction

Day by day, water is becoming a central issue in international affairs as a result of the growing competition over water resources. These resources are limited and stressed by the world's fast growing economy and population. This strong competitive attitude might lead to interstate conflicts or even wars, especially in countries already considered water scarce countries such as Syria. The country is classified by international standards as semi-arid to arid region with heavy dependence on agriculture in meeting the state's population food demand. Another distressing fact for the Syrians is that 70% of Syria's renewable water resources come from out of the country. These facts reveal the importance of transboundary waters to Syria.

So in the process of understanding the country's foreign policy perspective on transboundary water management, it is essential to identify the Syrian water situation and needs, the available transboundary resources, the interaction between these resources such as the Euphrates River and the Orontes River and the interlink between politics and transboundary water resources management. The study then concentrates on the case of the Syrian perspective on the Orontes river management.


2. The water situation in Syria


From 2006 to 2014, Syria went through eight years of drought, which affected many regions in the country and raised the pressure on the country's limited water resources. For the first time statements are made by the Ministry of Water Resources officials declaring that Syria has fallen under the water poverty threshold with less than 800 m³/capita/year availability. The total available renewable water resources in Syria for the year 2014 do not exceed 16 billion m³/year with a deficit of 7 billion m³/year needed to meet the water poverty threshold, which leaves a bigger gap between available water resources and water demand in the country (Alakhrass, 2014). So the water stress in Syria is a result of both a decline in the available renewable water resources and the increase in water demand.

Water poverty is a very complex term to define and there are a number of different ways to evaluate it using specially developed indicators. A study of water poverty in the MENA region was carried out including the Orontes three riparian states (Table 1). The study used a number of water poverty indicators to test the water situation in Lebanon, Syria and Turkey. Among these are the Falkenmark Indicator which is limited to the available water resources per capita per year with no relation to water quality, the Criticality Ratio Indicator which relates withdrawn water to available fresh water per year and the Social Water Scarcity Index, which is a complex water poverty indicator that relates the available water resources to socio-economic activities of a country (Jemmali and Sullivan, 2012). The study has shown that among the Orontes' three riparian states Syria has the worst water situation followed by Lebanon and then by Turkey. Syria suffers from water scarcity on all three levels of water availability, stress on renewable water resources and meeting water demand for socio-economic activities.

As a semi-arid to arid country Syria has very limited water resources and only the coastal region and the Orontes Basin in the country are excluded from this classification. The total renewable surface water resources, as pointed out previously, is 16.8 billion m³ of which 7.132 billion m³ are generated locally and 9.67 billion m³ are from transboundary resources (the Euphrates, the Tigris and the Orontes Rivers). These numbers lead to the fact that the dependence

Country	Falkenmark	Criticality Ratio	Social Water Scarcity Index
Lebanon	No stress	low stress	Beyond the barrier
Syria	Scarcity	Very high stress	Beyond the barrier
Turkey	No stress	No stress	Beyond the barrier

 No stress
on water resources

 Low stress
on water resources


 High stress
on water resources

Table 1: A comparison of water scarcity indicators in the Middle East (adapted from: Jem-mali and Sullivan, 2012).

ratio, which is defined as an indicator expressing the percentage of renewable water resources originating outside the country. For Syria the ratio exceeds 72% (FAO, 2005), which is a dramatic indicator to the dependence on transboundary water resources¹.

The dependence ratio of Syria on the Euphrates River is 50%, approximately 11% for the Tigris River and 11% for the Orontes River. This means that 11% of the water resources in Syria comes from the Orontes River and its basin which is heavily populated and cultivated. This is a very important point to consider when discussing the Syrian approach to the management of the Orontes River as a transboundary resource.

The pressure on the water resources in Syria is also increasing due to the sharp rise in population. The Syrian population grew from 13 million in 1992 up to 21 million in 2013. This fast growth resulted in a fast drop in available renewable water resources per capita (Figure 1).

¹ The equation used to calculate the percentage is the following: <http://www.fao.org/nr/water/aquastat/data/popups/itemDefn.html?id=4192>

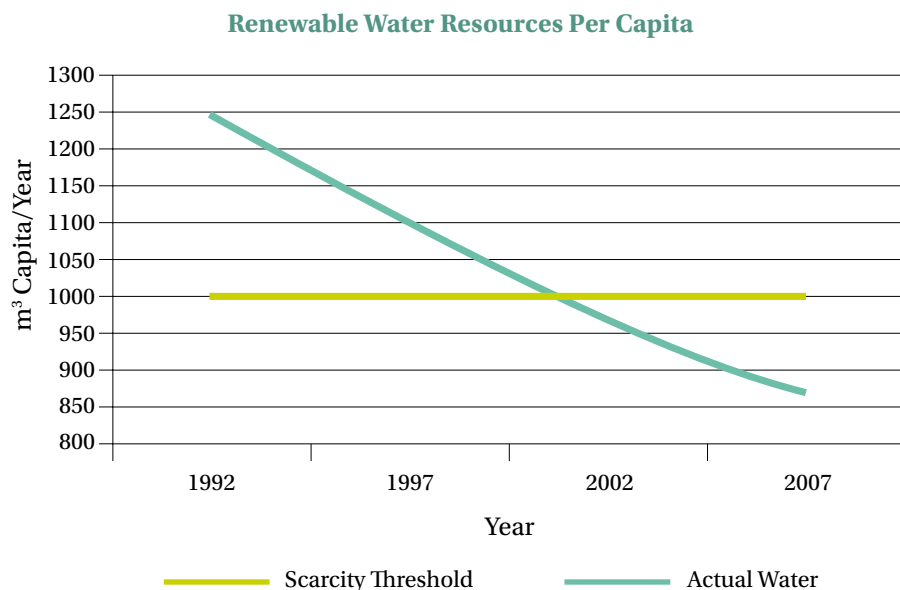


Figure 1: The drop in renewable water resources availability per capita in Syria (source: the author based on collected data)

To conclude, transboundary water resources play a major role in the water security² in Syria, as they represent 72% of the country's renewable water resources. This role is maximized by the heavy stress on water resources resulting from the fast population growth and the consequent growing economic demand.

² Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability (source: UN-Water, 2013). See: <http://www.unwater.org/topics/water-security/en>

3. Syrian transboundary water resources

Syria shares six main transboundary rivers with the neighboring countries Lebanon, Turkey, Iraq and Jordan. These rivers are the Nahr El-Kabir, the Orontes River, the Kwaik River, the Euphrates River, the Tigris River and the Al-Yarmouk River. Figure 2 shows the different transboundary water resources and related basins within Syria. It is clear that transboundary water courses and related basins cover most of the Syrian lands.

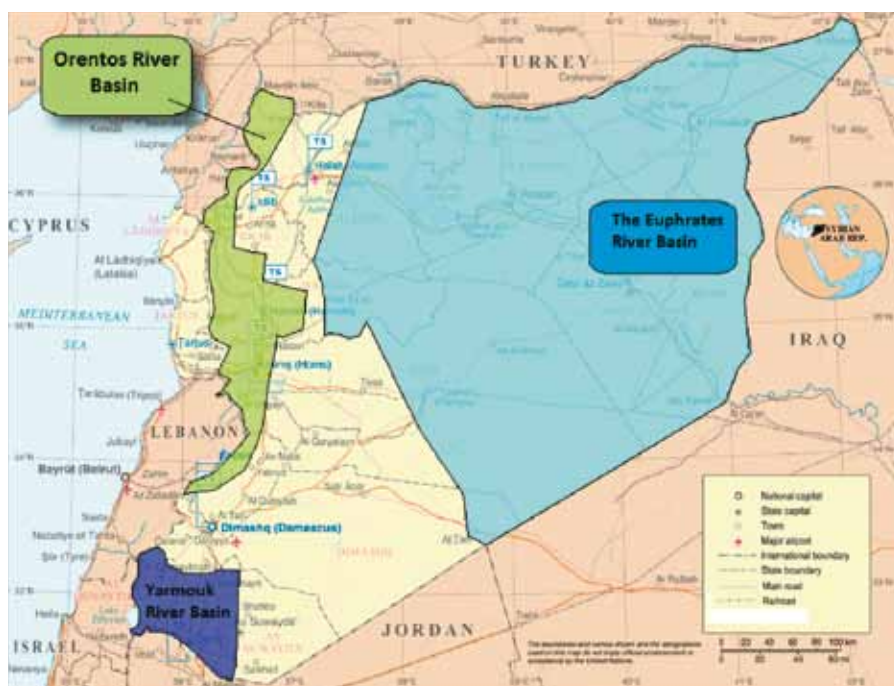


Figure 2: An approximate representation of Transboundary water basins coverage of Syrian territories covered by transboundary water basins (developed by the author based on the UN UNSMIS deployment map as of July 2012, n 4488 rev 3, July 2012, Wikimedia Commons)

Table 2 provides details on these transboundary water resources in relation to the Syrian Arab Republic.

This table shows that 17 million or 81% of the Syrian population depend directly on transboundary water resources to meet their water demands. Syria shares the Orontes, the Kwaïq, the Euphrates and the Tigris with Turkey, which makes the relation between Syria and Turkey rather unique. Turkey is the upstream country of all the shared rivers apart from the Orontes giving the country the upper hand in the management of these resources. Also, Syria shares the Orontes and Nahr El-Kabir with Lebanon, where Lebanon is the upstream country for the Orontes while Syria is the upstream country for the Nahr El-Kabir. Syria is also the upstream country for the Al-Yarmouk River. This discussion shows that Syria is not in a good position to negotiate as a downstream riparian state for all major shared water resources.

In addition to the above mentioned points, agriculture is of great importance to Syria's plans for achieving food self-security and to the economy through increasing exports reducing rural internal migration. The agriculture sector

River	Basin Population		Dependency Ratio (%)	Location	Riparian States	Status
	(million)	%				
Orontes	4.2	74	11	Downstream	Lebanon, Syria, Turkey	Flowing
Nahr El-Kabir	0.43	81	-	Downstream	Syria, Lebanon	Seasonal
Kwaïq	5.42	97.8	-	Downstream	Turkey, Syria	Dry (Syria)
Euphrates	5.7	25	50	Downstream	Turkey, Syria, Iraq	Flowing
Tigris	0.05	0.2	11	Downstream	Turkey, Syria, Iraq, Iran	Flowing
Al-Yarmouk	1.26	18	-	Upstream	Syria, Jordan	Flowing

Table 2: Dependence of the Syrian population on transboundary water resources

provides more than 25% of the Syrian national income. More than 30% of Syrian labor force works in this field and more than 21% of the cultivated land is irrigated using transboundary water resources.

The impacts of the Syrian's heavy dependence on transboundary water resources have driven the Syrian government to develop a clear strategy for dealing and managing transboundary water resources. The strategy was implemented for all transboundary resources with no exception and the case of the Kwaiq River represents a living example of the failure result in protecting these resources. The river used to bring life and joy to the city of Aleppo has turned into a dump yard in the last decades after the dramatic drop in the river flow due to the heavy exploitation of the river basin in Turkey.

4. Syrian perspective on transboundary water management

It is true that the competition over water resources can lead to conflicts but it can also be a catalyst for initializing international cooperation. Due to this fact, transboundary water resources management in Syria is a collaborative task between the Ministry of Foreign Affairs and the Ministry of Water Resources (previously Ministry of Irrigation). The Ministry of Water Resources is responsible for technical issues and cooperates closely with the Ministry of Foreign Affairs in all international negotiations, conferences and meetings.

The Syrian foreign policy regarding the management of transboundary water resources employs a technical approach based on international laws and practices supported by a firm political will for protecting Syrian transboundary water interests. This approach helped Syria in getting other riparian states into negotiating, especially Turkey which is an upstream country in the case of the Euphrates River. For instance, the security agreement signed in 1986 by Turkey and Syria is a good example of this approach, where a political agreement was annexed with a transboundary water agreement. In this annex, Turkey agreed to allow a yearly average flow of 500 m³/s through the Euphrates River to enter Syria. The flow is to be measured at the Turkish-Syrian border. In spite of the fact that this agreement is a temporary measure, this is the first time that Turkey and Syria have signed an agreement that provides a written commitment by

Turkey for a certain flow in the Euphrates. The agreement sets example for the fact that cooperation over water can help in building trust as it marks the end of a hectic era between Turkey and Syria, which brought the two countries very close to war over accusations by Turkey to the Syrian government of supporting PKK rebels. The agreement was considered by Syria as the first step towards achieving a fair sharing of the Euphrates resources. The cooperation between the two countries over shared water resources developed dramatically after this agreement but unfortunately, the current crisis in Syria diminished these relations and stopped, nearly, all cooperation over water issues. In general the Syrian perspective regarding transboundary water sharing can be described as flexible. For instance, Syria signed with Lebanon an agreement for sharing the Orontes River in 1994. By 1997, the same agreement was reviewed and modified to exclude a number of water resources out of the agreement scope and to the benefit of Lebanon. Again, the agreement was amended in 2001, giving the right to Lebanon for establishing dams on the Orontes River. The water sharing agreement was modified twice in less than ten years showing the Syrian flexibility towards Lebanon.

The analyses of the Syrian approach for the management of transboundary water resources shows that the Syrian perspective is based on the following five points:

- No concession over the Syrian share in any of the transboundary water resources. This principle is emphasized by the fact that all water treaties and agreements are to be approved by the highest leadership in Syria. A clear example of this point is the collapse of the peace talks' process between Syria and Israel in 2000. Sharing the Tiberias Lake waters was one of the main factors leading to this result. From the Syrian point of view, Syria does not have the luxury of losing water rights over transboundary water resources. A belief supported by the fact that Syria is now under the water poverty threshold.
- Syria will engage in any international initiative or agreements involved in the management of transboundary water resources and will play a pivotal role in the articulation of such activities. Syria was very active in adopting

and promoting the UN Watercourses Convention. The country was one of the earliest to sign this agreement. Syria has lobbied for promoting this convention and was successful in getting the support of many of the early signing countries such as Jordan, Lebanon, Tunisia, Yemen, Qatar and Libya. Many of these countries do not have strong interests in transboundary water issues specially water courses such as Tunisia and Libya, while others have very strong relations with Syria especially over transboundary water issues such as Jordan and Lebanon. The adoption of this convention, according to the Syrian perspective, was a strong message to Turkey that things are starting to change on the international level regarding transboundary water resources. Unsurprisingly, Turkey refused to attend the convention making it the only riparian state on the Euphrates and the Orontes not to join the agreement.

- Since independence, Syria has worked on utilizing all available transboundary water resources in irrigation projects but these activities have grown dramatically since the 1980s. The aim was to meet the ever growing food demand resulting from the rapid population growth and at the same time establishing a status quo which will help Syria protect its rights in water resources and support the Syrian claims. For instance, the Syrian and Turkish efforts in utilizing the Euphrates are a clear neck-to-neck competition in establishing Status Quo. In this effort, the Syrian government was able to nearly double the irrigated lands since 1987 (Haddad et al., 2008).
- One of the main points raised in any negotiations over transboundary water resources is water use efficiency. This issue was brought up in all negotiations between Turkey, Syria and Iraq in their bilateral and tripartite meetings. The Syrian response to this point was launching a project to reform the irrigation sector and modernizing the irrigation process at national level and at farm level. The project started in 2005 with a dedicated budget of 1 billion USD (Palestinian Business Forum, 2010). Another approach for increasing water use efficiency is to adopt Integrated Water Resources Management concepts in planning and managing water resources. A direct result of this approach is the merger of all authorities responsible for the water sector in one ministry named the Ministry of

Water Resources, which was established by presidential decree No. 44/2012.

- The Syrian government has an integrated vision for the management of transboundary water resources putting all economic and political cooperation with neighboring countries at the service of this sector. For instance, the management of the Orontes River is supervised by the Syrian-Lebanese Higher Council headed by the Syrian and Lebanese Presidents. In the two countries the Council is the highest authority responsible for drawing up the political and economic cooperation strategies, which reflects the importance of the shared waters for both countries. Another agreement that reflects this principle is the Syrian-Turkish Strategies Cooperation Council. The agreement covers cooperation on shared water forums, focusing on water quality of shared resources, and cooperation on developing shared water pumping stations and dams and a joint water policy.
- Another Syrian approach is that, as politics is in the service of transboundary water resources management, these same resources serve general politics. In 1999, Jordan was under pressure from Israel which was preventing water from flowing into the Jordan River and Jordan was suffering from severe shortage in water supplies. Syria agreed to supply Jordan with extra seven million cubic meters during the summer of that year. The supplied water helped in enhancing the political relations between Syria and Jordan.

Syria has worked on resolving all transboundary water resources with neighboring countries with the aim of settling and confirming the Syrian right on these resources. Syria has already signed agreements with Lebanon for sharing the Orontes and Nahr El-Kabir Rivers, an agreement with Jordan for cooperation over the Al-Yarmouk waters and an agreement with Iraq for sharing the Euphrates and Tigris. The situation between Syria and Turkey is more complex. The two countries share the Orontes River and its tributaries, the Kwaik River which dried up due to bad management, the Euphrates River and its tributaries and the Tigris River. The transboundary water agreements between the two countries are either temporary or part of a more general agreement. Syria links any deal on the Orontes River to achieving a deal

on the Euphrates River. This is due to the fact that Turkey is a downstream riparian state on the Orontes River, while Syria is a downstream riparian state on the Euphrates River. In general, the previous discussion shows that Syria is working hard on sorting out the transboundary water resources issues with other riparian states.

The discussion in this chapter provides a descriptive reading of the Syrian perspective towards the management of transboundary water resources and does neither evaluate the failure nor the success of this perspective as it is out of the scope of this study.

5. The Orontes River

The Orontes River is known as the *Asi* River in Arabic and Turkish, meaning the “Rebel” as it is the only river in Western Asia flowing from south to north. It is also known as the *Arnt* (“Lioness” in Syriac language) and the *Alimas* River (“Water goddess” in Aramaic). It constituted the cradle of civilization for central Syria throughout history. The Orontes is shared by three riparian countries, flowing from Lebanon through Syria to Turkey and then discharging into the Mediterranean Sea. The river originates in Lebanon from the springs of Labweh not far from the city of Baalbek, runs through the Bekaa Valley and further northward parallel to the Lebanon and Anti-Lebanon Mountains, collecting on its path water from a number of springs and intermittent canals, when entering Syria close to the town of Hermel. In Syria, the river passes the Zeita Dam to its left and expands then into Lake Qattineh. This reservoir dam, according to some studies dating back to 2000 BC, is constituted of natural basalt which was raised to seven meters in 1930 increasing the storage capacity of the artificial lake up to 250 million m³. The river then continues to the north through the cities of Homs and Hama and the fertile Ghab Plain. It defines 31 km of the Syrian-Turkish border before flowing through the province of Hatay (Iskandaronatt) to the Mediterranean Sea. The Orontes has two main tributaries, the Afrin and the Karasu Rivers. The Karasu River (the black river) originates in Turkish territory and forms over a short distance the border between Turkey and Syria, while the Afrin River crosses Syrian territory before

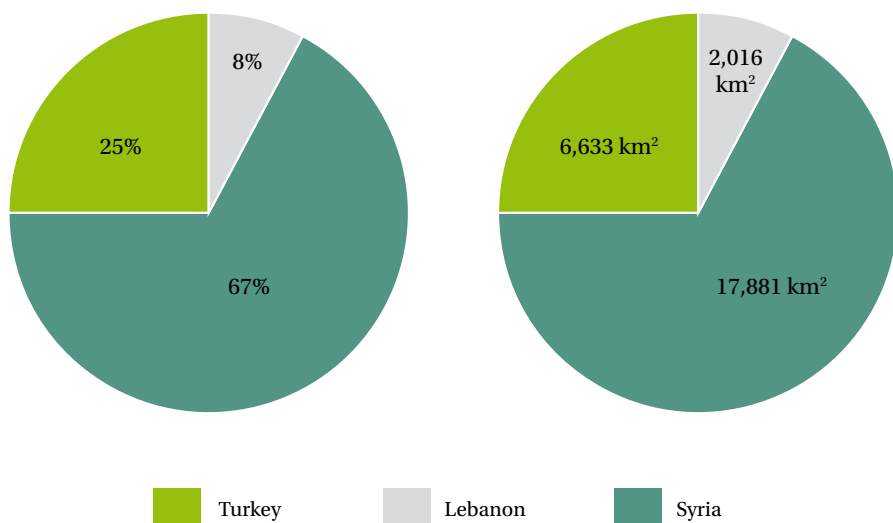


Figure 3: Share of the Orontes River Basin among Lebanon, Syria and Turkey (developed by the author)

flowing through the Turkish Amik plain. The Orontes main course has a total length of 448 km, of which 83 km in Lebanon, 280 km in Syria, 27 km along the Syrian-Turkish border and 59 km in Turkey. The river basin covers an area of 26,325 km² in the three riparian states, of which 7.6% situated in Lebanon, 67.4% in Syria and 25% in Turkey (Figure 3).

Since 1940 the river has witnessed dramatic changes in its hydrological system. The first major change was the drying up of Lake Amik in the Hatay (Iskandaronatt) region due to the draining of the lake and the diversion of its tributaries directly into the Orontes River. By 1970 the lake dried totally up and the land was reclaimed for agricultural activities. The drying of the Ghab marshlands in Syria between 1958 and 1968 constituted the second major hydrological change. Both projects caused a dramatic increase in the river basin's irrigated land. Figure 4 illustrates a simplified version of the Orontes hydrological system, showing the complexity of the northern part of the river as it draws with its tributary the border between Syria and Turkey.

5.1 The utilization of the Orontes water

5.1.1 Lebanon

In Lebanon, surface water irrigates approximately 87,800 ha of which 11,500 ha are located in northern Lebanon. Unfortunately, the available information on the area of land irrigated by the Orontes is contradictory. The Ministry of Energy and Water gives an estimation of 1,703 ha, whereas FAO refers to an area of 18,000-21,000 ha (ESCWA, 2013). These data show a big discrepancy which applies to the use of the Orontes waters in Lebanon. According to Lebanese estimations only 21 MCM of Orontes water is consumed annually in Lebanon. On the other hand, measurements at the Lebanese Hermel station and at the Omeiry station on the Syrian-Lebanese border show an annual consumption of 202 MCM in the region. The Orontes flow generated in Lebanon is estimated at 410 MCM/year, hence the amount of water consumed by Lebanon - based on the previous measurement - corresponds to 50% of the river's flow. This fact is one of the reasons that urged the Syrian government to engage in negotiations and to sign an agreement, which legally regulates the Lebanese water share of the Orontes River.

5.1.2 Syria

Syria has heavily developed surface (and ground) water resources in the Orontes Basin. In the 1950s, this basin was the key to achieving food security in Syria as the Orontes and coastal regions constitute the only regions of Syria outside the semi-arid and arid areas. This condition explains the importance of the Orontes region as a very promising land resource for agricultural development. For this reason the utilization of the Orontes River started under French Mandate and at the beginning of Syrian independence in the 1940s. Between 1958 and 1968, Syria initiated a marsh drainage project resulting in the reclamation of 46,000 ha of land. The second development phase was initiated by Presidential Decree No.3/1972 and involved the construction of a number of dams and flow regulators. Data from the Ministry of Water Resources (previously Ministry of Irrigation) give account of the construction of 41 dams on the Orontes River and its sub-basins: 2 hydropower plants (Al-Rastan and Mahardeh), 20 irrigation dams, 1 dam used for both domestic and irrigation purposes known as Dam 17 April in the Aleppo governorate, 6 flood prevention dams, 3 percolation

dams and 9 dams used for livestock. According to a World Bank study of 2001, the Orontes provides 20% of Syria's total water use and the agricultural sector consumes 85% to 90% of the Orontes River waters.

5.1.3 Turkey

The Orontes River enters Turkey through the Amik Plain, flowing to the east and discharging into the Mediterranean Sea. The Amik plain was a lake with few natural drainage canals and used to flood nearby fields and villages. In the 1970s, the General Directorate of State Hydraulic Works (DSI) launched a project for drying the Amik Lake by draining its water and reclaiming the resulting land. Since then the Amik Plain developed into a significant agriculture asset for Turkey. Currently Turkey is engaged in the planning and implementation of 12 projects for the management of the Orontes and its tributary waters. The projects serve domestic and irrigation needs, protect from flooding and generate hydropower. Upon commissioning all projects, the irrigated land in the Turkish Orontes part is estimated at 100,000 ha and the generated hydro-power at 180 Gwh/year.

The river is highly polluted in the midstream and downstream due to heavy industries such as cement and fertilizer plants, power stations and other industrial activities disposing of their waste in the river. In brief, the Orontes Basin is heavily exploited by the three riparian states with no clear integrated vision for the management of the river resources.

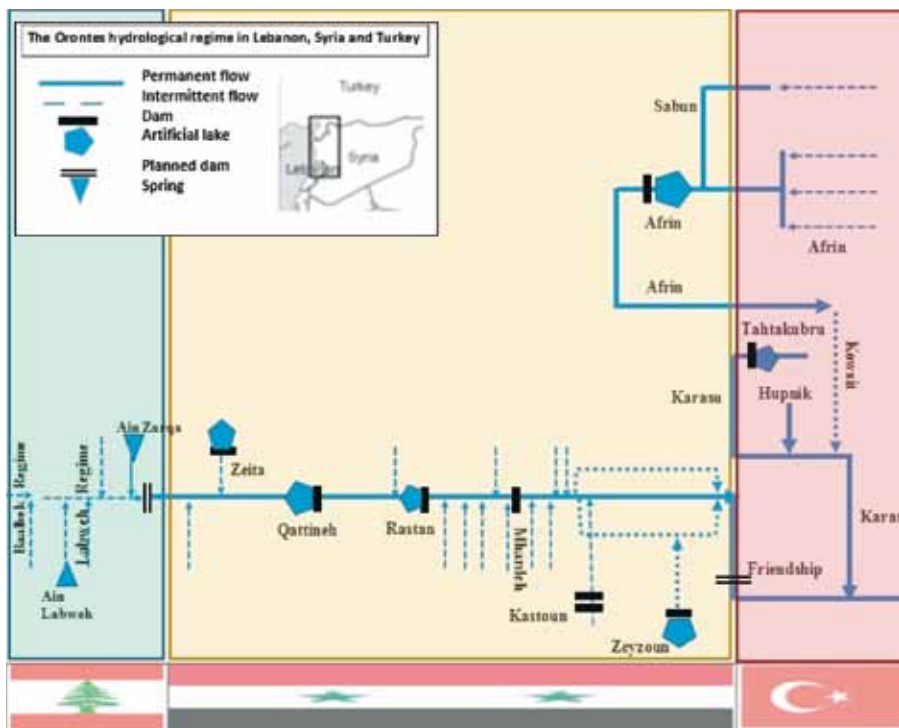


Figure 4: A simplified illustration of the Orontes hydrological system (developed by the author)

6. The Syrian prospective on the management of the Orontes waters

As discussed previously, the Orontes River is shared by Lebanon, the upstream country, Syria, the midstream country, and Turkey, the downstream country. There is neither a general agreement for sharing the river nor a comprehensive vision shared by the riparian states for the management of the river resources. The prevailing attitude is basically competition especially between Syria and Turkey. Syria and Lebanon have signed an agreement for sharing the Orontes River, an agreement which has been modified twice in seven years. Syria and Turkey do not have an independent standing agreement for the management of the river. The cooperation over the river is just a part of more general agreements. Based on this discussion, the cooperation over the Orontes can be distinguished into two parts, namely, Lebanon and Syria on one hand and Syria and Turkey on the other. In both cases Syria has implemented its five-pillar approach discussed in Section 4 of this Chapter.

6.1 Syria-Lebanon

6.1.1 General description

Syria and Lebanon have very strong demographic, economic and political ties which make the relationship between the two countries very special, as expressed in the saying: “the Syrian and Lebanese people are one people in two countries”. These close ties resulted in 1991 in the signing and ratification of the Fraternity, Cooperation and Coordination Treaty, by which the Syrian-Lebanese Higher Council headed by the Presidents of the two countries was established. To follow up the cooperation between the two countries, the Council created a number of joint committees, among which the Lebanese-Syrian Joint Committee for Shared Waters. This Committee is the central entity which supervises and coordinates the cooperation between the countries and the planning concerning shared water resources and which has set up a specific Joint Committee for the management of the Orontes River waters.

As described previously, the Orontes water resources are heavily utilized in Syria in irrigation, fishery and dams, while according to the Lebanese Ministry of Energy and Water exploitation in Lebanon is limited to small irrigation

projects, small fish cultures and a number of wells in the Ka'a region. The figures of the irrigated area in the Orontes Basin supplied by the Ministry are very limited compared to those provided by the FAO, as discussed previously. Also, the difference in water flow between the measures taken at the Al-Hermel station and those recorded at the Omeiry station on the Lebanese-Syrian border requires further investigation as it shows a great discrepancy with the consumption declared by the Lebanese Ministry.

The initiatives aimed to build dams and manage the basin have not facilitated the achievement of a sharing agreement, which however was signed on 20/09/1994 in Damascus, Syria.

6.1.2 Agreements

The negotiation process between Lebanon and Syria goes back as far as the 1940s, when a Syrian-Lebanese Joint Committee was established to deal with the Orontes. The committee allocated an annual share of 100 MCM of water to the Hermel and Ka'a regions in Lebanon. Later in 1968, the committee decided to re-consider the annual water needs of both countries. Syria, on the other hand, offered to build a number of dams and flow regulators on the Orontes course within Syria with the aim of helping Lebanon in managing its waters. The process resulted in a bilateral agreement regulating water use in the Orontes River Basin. The agreement was signed by both parties in 1972. It is very important to note that this agreement is not limited to the river, but it also covers water use in the basin. Unfortunately, due to the circumstances in Lebanon and Syria and the political complexity, the agreement was never implemented. The agreement still has a special importance for the Orontes river management as it represents the first document in which Syria recognizes the river as an international river. Syria always considered the Orontes River as a national river discharging into the Mediterranean Sea through the Syrian land. The special relations between Syria and Lebanon led to this special deal, since Syria was using for a very long time the same argument with Turkey. This fact will be discussed in details in the section on the Syrian-Turkish cooperation over the Orontes.

On the 20th of September 1994 a bilateral agreement for sharing the Orontes River was signed by the Minister of Energy and Water in Lebanon and the

Minister of Irrigation in Syria. The agreement regulates water use of the Orontes River between the Lebanese Republic and the Syrian Arab Republic. The major points of the agreement are the following:

- The agreement recognizes the Orontes River as “shared waters”.
- The agreement defines the river’s headsprings and their boundaries together with the average annual discharge of an average year flow.
- The agreement allocates a share of 80 MCM/year of the Orontes flow to Lebanon and 340 MCM/year to Syria, provided that the river’s resources reach no less than 400 MCM/year.
- It was agreed that in case the annual discharge of the river falls below 400 MCM, Lebanon’s share will be reduced to 20% of the river flow.
- A special Joint Technical Committee composed of experts from both countries is formed to manage the river flow within Lebanese territory. The Joint Technical Committee is to be financed by Syria.
- The parties’ commitment to the agreement will be evaluated by a joint arbitrary committee. If the committee fails to resolve any conflict then the problem will be transferred to a higher committee.
- Syria will be notified about any further river installations and related usage and about all water extraction from existing wells which will be considered part of Lebanon’s 80 MCM/year share.
- The agreement describes in great details the river flow and the related Lebanese share. It divides the annual river flow into four different phases of several months each and establishes specific flow allocations for each phase.

Many Lebanese analysts considered the agreement unfair on Lebanon, claiming that it had been reached under the Syrian political influence on the country. The agreement became a very controversial issue and critics argued that it suffered from the following drawbacks:

- The agreement gives the Syrian authorities the right to observe, measure and control the Orontes River over Lebanese territories which would undermine the Lebanese sovereignty.
- The agreement allocates more than one third of the Lebanese water share from the Orontes river flow to the winter period which would prevent

Lebanon from benefiting from this share for irrigation and development purposes.

- Lebanon does not dispose of any water structures to store Lebanon's share for better management. On the other hand, the agreement prevents Lebanon from obstructing the river flow, which means that Lebanon will not be allowed to build dams.

The agreement remained a very “hot” topic in the Lebanese media, leading to negotiations between the two governments, whereby the initial agreement was amended following direct contacts between the Head of the Lebanese Parliament Nabih Barri, the Lebanese Prime Minister Rafik Al-Hariri and the Syrian President Hafeth Al-Assad. These consultations and the high level negotiation reflect the importance of transboundary water resources for both countries, the strong role of politics in the issue, and the fact that at certain stages decisions related to transboundary resources in Syria are limited to the Head of State due to the high sensitivity of the subject. As a result of these efforts, the original 1994 Agreement was amended in 1997 by adding an annex that identified four sub-basins as “closed basins” as well as a main spring, which were to be excluded from Lebanon's annual share as settled in the 1994 Agreement.

Nevertheless, some Lebanese parties continued to criticize the agreement as it prevented Lebanon from constructing dams on the river's course. They claimed that this condition undermined the ability of Lebanon to achieve an optimal use of its share of the Orontes River. The situation continued until 1999, when heads of the two states decided to have a full review of the sharing agreement and annexes. Again, the problem was resolved when the heads of the two states met in early 2002 and approved a new modified version of the Orontes River sharing agreement. The new agreement gave the green light for the erection of two dams. The first is a derivation dam with a capacity of 27 MCM and serves both countries, while the second dam is a multi-purpose dam with a storage capacity of 37 MCM, serving Lebanon. The box below provides the translation from Arabic into English of the main points of the agreement as available on the website of the Syrian Ministry of Water Resources. More than a decade after signing the agreement between Syria and Lebanon

20/09/1994. Agreement on the allocation of the Orontes River waters between the Syrian Arab Republic and the Lebanese Republic. The Agreement was ratified by law number 15, dated 1/12/1994.

The Lebanese share has been set at 80MCM for an average year (an average year has a flow not below 400MCM/year) or 20% of the river flow for years with a lower flow than an average year. The Lebanese share includes all current water quantities used for domestic and irrigation purposes and withdrawn directly from the river and the surrounding springs and wells. Decision on water shares will be based on flow measurements at the Al-Hermel Bridge, on water flow of springs, rainfall and streams contributing to the river and water pumped from wells within the direct buffer of the river banks and within a distance of 500 m from either side of the river bank or wells located within a circle of radius 1,500 m centered on the Ain Zarqua or Al-Hermel or Rassellmall spring or any of the springs which contribute continuously to the Orontes River or any other spring nominated by the Joint Technical Committee. The Joint Technical Committee from the two countries supervises the measurement procedure of the river flow and all withdrawn waters from the river, springs and pumps mounted on the river course within the Lebanese territories and up to the Syrian borders.

It has been agreed that:

The four water basins of Al-yamouneh, Merjhein, Jbab Alhumr and Arghash are considered closed basins and the Lebanese side can invest in the water resources in these basins within the limits of the renewable water resources of each basin. The renewable water resources are decided by both sides, Lebanon and Syria, and through the Joint Technical Committee.

The Syrian side recognizes the needs and agrees to supply the residents of Balbak and Al-Hermel with the full yield of the Labweh spring during the irrigation period extending from mid-April to mid-October and agrees to the already existing supply for domestic use to the villages of Labweh, Amhez, Altawfiqieh, Alein, Alnabiothman, Sabboughah, Al khriabeh, Halabna and Al-Jaboulah. For the remaining period of the year, the water flowing from the Al-Labweh spring or any rainfall flow in the region will be allowed to contribute freely to the Orontes river flow at Al-Hermel Bridge. On the other hand the Lebanese side is committed to restrain from constructing any structures which might restrain any of the springs or streams from flowing into the Orontes River. The Joint Technical Committee is to carry out all the necessary measurements required to decide flows at different parts of the river.

On 03/03/2002, the Syrian-Lebanese Higher Council agreed on the construction of a dam on the Orontes River in Lebanon. This approval was a concrete interpretation of the Orontes Sharing Agreement and represented a great leap towards the launching of the Ka'a and Al-Hermel irrigation projects.

for sharing the Orontes, complaints and objections to the agreement are very limited. The Lebanese and Syrians look upon this agreement as the first of its kind in the Middle East and a leading process for the region. The only drawback of the agreement is the absence of Turkey.

6.1.3 International practices

Syria and Lebanon both signed the UN Convention on non-navigational international watercourses. This fact urged the two countries to use the principles of the convention in reaching the 2002 Orontes water sharing agreement. The agreement is considered by many experts as a success in achieving a win-win situation for both riparian states. The agreement evolved over a decade of discussions and modifications and was built on the principle of achieving equitable and reasonable use of the river by encouraging cooperation between the riparian states. These two principals are met through the flexible scheme adopted in deciding the water share of both Syria and Lebanon based on the river's annual flow. Also, the agreement supports the cooperation between the two riparian states through a Joint Technical Committee managing the river's affairs and the cooperation between Syria and Lebanon by building a dam of mutual benefit to the two countries in an effort to achieve reasonable use of resources. The agreement respects the principle of not causing significant harm by considering the river a joint resource. The agreement, similarly to articles 8 and 9 of the UN Convention, sets up a process for monitoring the river's hydrology, eco-system and pollution prevention through a special committee serving this purpose. The latter point by itself is considered an achievement as it is the first time to have a shared committee, which protects shared water resources from pollution and illegal uses in the Middle East. The agreement falls short of the convention due to the fact that it excludes Turkey.

6.1.4 Management

The Orontes River water management is carried out by the Orontes River Joint Committee, which answers to the Syrian- Lebanese's Joint Committee for Shared Water.

The river committee supervises the work of two sub-committees. The first committee is responsible for the protection of the river, its environment and

hydrology. The second sub-committee is responsible for expropriation of lands related to projects on the Syrian Lebanese Borders.

The subcommittees meet every month in Lebanon or Syria to discuss the river related issues and to exchange data and water quality analysis tests. The subcommittee takes the necessary measures to tackle problems such as violations along the river's course related to sewage, fisheries or illegal pumping. The table below gives more details on the river management committees.

Syrian-Lebanese Higher Council			
Syrian-Lebanese Joint Committee for Shared Water			
Orontes River Joint Committee			
Sub-Committee for River Protection and Environmental Preservation			Sub-Committee for the Expropriation of Lands in the Vicinity of the Zeita Canals
Committee on River Hydrology	Committee on River Pollution	Committee on River Infringements	
Exchange of river data, supervision of hydraulic structures and control of wells and pumping systems.	Monitoring water quality, control of river pollution and coordination of sewage solid waste management in the river region.	Control of illegal works.	<ul style="list-style-type: none"> • Attribution of financial compensations related to the expropriation of lands. • Control of violations and illegal works on the canals.

Table 3: Established river water committees

With the aim of strengthening the legitimacy of the Orontes sharing agreement and gaining international recognition out of it, Syria supported Lebanon in soliciting international donors for assistance in water supply management, hydrological monitoring and in the launching of various projects. Among

these projects, the construction of the Assi Dam, started in 2004 by a Chinese company. Unfortunately the construction site was bombed during the 2006 assault and since then the project is halted.

6.1.5 The Syrian perspective in cooperation with Lebanon

Water agreements over the Orontes River between Lebanon and Syria date back to 1972 after which negotiations stopped for 20 years until a sharing agreement was reached in 1994. This agreement regulates the sharing of the Orontes between Lebanon and Syria and describes the activities needed for implementation. In general, the agreement builds on the 1972 Agreement in terms of Lebanon's share of the Orontes River but it adds further restrictions to any future developments on the Lebanese side. Moreover, the agreement does not reflect the information available to the Lebanese Ministry of Energy and Water, which concerns four closed basins and already allocated resources essential for many villages and towns, not taking into consideration the irrigation needs of the region. In spite of the fact that the agreement had been ratified and turned into law in both countries, Syria was flexible to review the agreement and accept the modifications proposed by Lebanon. The Amendment to the Agreement was agreed in a meeting between the Syrian President Hafeth Al-Assad, the Lebanese Prime Minister and the Head of the Lebanese Parliament, which confirms again the importance of transboundary waters to both countries.

Furthermore, Syria deliberately linked most of the items in the final agreement to the UN Convention for two reasons: first to give the agreement an international recognition and secondly to use this agreement as an example of cooperation in the Middle East, especially for Turkey. Turkey requests an extension of the agreement to include all the riparian states. However, such a request will put Turkey in a very weird position as Syria, in turn, will be asking Turkey to reach a similar agreement for the Euphrates River. For this reason the agreement between Lebanon and Syria is criticized by Turkey, though not that loudly.

Syria proved to be flexible and cooperative throughout the entire negotiation process and did not hesitate to withdraw some of its demands for the benefit of Lebanon, but the main achievement for Syria was the fact that for the first time

it has the right to monitor, measure and protect the river flow on Lebanese territories through a joint Lebanese-Syrian committee.

The agreement over the Orontes and Nahr El-Kabir Rivers between Syria and Lebanon meant for Israel that Lebanon had resolved all issues concerning its shared water resources in northern Lebanon and that the next step would concern the southern Lebanese waters shared with Israel. In this context, the destruction of the Orontes Dam by Israeli attacks during the 2006 aggression provides strong evidence of the Israeli dissatisfaction with this agreement.

6.2 Syria-Turkey

6.2.1 General description

Sharing the Orontes River between Syria and Turkey is a more complex task than the situation between Lebanon and Syria due to the difficult political situation between the two countries. The complex political climate between Syria and Turkey is dramatically reflected on all cooperation efforts including transboundary water resources management. The following discussion explains the conflicting political climate that prevails between the two countries and its effects over transboundary water resources.

The differences between Syria and Turkey regarding water resources are not the only cause of conflict between the two countries. Another major disagreement is a territorial dispute over the Hatay (Iskandaronatt) region. This dispute has a major impact on the sharing of the Orontes River, because according to the Syrian claims over the region the river is to be considered a national river. In other words, Syria does not have to negotiate with Turkey over the Orontes River. The Syrian claims to Hatay are based on the fact that until 1939 the region was a part of the Syrian Republic. Syria does not recognize the Turkish annexation of the region the way it was performed under the French occupation (Mandate) of Syria. Consequently, Syria considers all resulting rights for Turkey over the Orontes River as illegal. Based on this discussion, both parties do not have a shared status for the shared resources, where Syria considers the Orontes River as flowing within Syrian territories, only Turkey considers the Orontes as a transboundary water resource calling for equitable use of the river. On the other hand, Turkey sees the Euphrates as an

“International River” which in the Turkish perception means that – due to the limited contribution of Syria and the absence of any contribution from Iraq to the river’s resources – the two countries have the right to share the river waters but no right to claim equitable use. In this context, it is important to clarify that the international water diplomacy terminology does not make any distinction between the two wordings “International Rivers” and “Transboundary Rivers”, which contradicts the Turkish position. So no real achievements can be claimed over the Orontes and the Euphrates until the two countries agree on the status of the two rivers.

Another important and conflicting issue is the strong competition between Syria and Turkey in developing unilateral plans for expanding their irrigated areas. This competition is not only limited to the Orontes River but is also to be observed for the Euphrates River. Both states aim at establishing a status quo in support of their claims on the river’s waters. These unilateral developments are putting a very heavy strain on both rivers. The disastrous fate of the Kwaiq River keeps Syria on the alert for the Turkish intentions.

On the other hand, Turkey keeps accusing Syria of harboring and supporting PKK (Kurdistan Workers’ Party) terrorists on Syrian territories. This issue is very sensitive in Turkey, which has been fighting PKK for a long time. These accusations caused a very hostile atmosphere in the 1990s, witnessing a dramatic escalation of the conflict between the two countries, specifically over the support to the PKK. In 1996, the relations between the two countries reached a breaking point and Ankara decided to cut all diplomatic ties with Damascus. Turkish sources attribute this retaliation to the Syrian’s refusal to expel the PKK leader from the Syrian territories. On the other hand, Syria denies any links to the PKK or its leader Abdullah Ocalan. The situation between the two countries started to change with the signing of the Adana Security Agreement in 1998.

The installation of Bashar Al-Assad as the new Syrian President launched a new era of good relations between the two countries. The relations continued to develop extremely well up to the beginning of 2011. During this period the two countries made significant progress in cooperation in many different economic sectors, with the exception of the field of transboundary waters. Both governments considered transboundary water resources a big obstacle

in the development of their interrelations and avoided any discussion on the issue before creating a strong climate of trust between the two states.

In 2009, Turkey and Syria signed a Memorandum of Understanding for the construction of a joint dam on the Orontes River, the so-called “Friendship Dam”. This agreement represents the first joint collaboration on the Orontes River between Syria and Turkey since the Syrian independence. The agreement constitutes a very promising path towards a new cooperative future between the two countries, which has led many experts to envisage a sharing agreement on the Euphrates River. Unfortunately, the ongoing crisis in Syria since 2011 generated a deep conflict between the Syrian government and the Turkish leadership, whereby the future of the “Friendship Dam” has become uncertain.

6.2.2 The negotiation process

Early negotiations on the Orontes between Syria and Turkey date back to the 1920s and deal with borders, water resources and irrigation. All agreements of this period were negotiated by France as mandatory power on behalf of Syria. The agreements signed in this period include:

- The Ankara Treaty of 1921 negotiated by Turkey and France as mandatory power on behalf of Syria. Article 12 of this treaty discusses “water apportionment” and water supply for the city of Aleppo.
- The Convention of Friendship and Good Neighborliness signed in 1926. The agreement was negotiated by Turkey and France as mandatory power on behalf of Syria. The agreement discusses the provision of water supply and irrigation in Aleppo.
- The protocol of 1930 issued by the League of Nations describing equitable utilization of waters for navigation, fishing, industrial and agricultural uses between Syria and Turkey.
- The Final Protocol to Determine the Syria-Hatay Border Limitation, signed in 1939. The protocol was negotiated by Turkey and France as mandatory power on behalf of Syria. The agreement defines where the Orontes River and its tributaries constitute the border between the two countries and states that the streams and tributaries forming the borders are to be utilized in an equitable manner on both sides.

It is very important to understand that Syria does recognize most of the previous agreements as they have been negotiated or signed on behalf of Syria by France as the mandatory power at that time. Syria does not use the term mandatory but the term occupation when referring to the French presence in Syria for the period 1920-1946.

In the 1950s, Syria launched a project to build a number of dams for draining and reclaiming the Ghab marshlands. An agreement was signed in 1950 between Syria and the World Bank to fund the project. The World Bank, convinced that the project would not restrain the Turkish share of the river flow, mediated between Syria and Turkey to promote the project and to minimize the Turkish concerns. The Bank believed that the project would help in controlling winter floods and would provide enough water for irrigation in summer. Getting the World Bank to mediate in favor of the project was a big achievement for the Syrian government as the project gained international legitimacy owing to the credibility of the World Bank, minimizing the Turkish objections.

During the implementation of the Ghab project in Syria, Turkey tried to promote a comprehensive draft for the development of the entire Orontes River Basin, which included monitoring facilities, flood early warning systems, flood mitigation measures and a dam for irrigating the Amik plain. The Syrian government was not interested in the proposal due to the bad relations between the two countries over the Euphrates River. According to the Syrian perspective the two rivers are interlinked and the success in addressing the conflicts over the Euphrates River will help resolving conflicts over the Orontes River.

The same period witnessed negotiations between Syria and Lebanon and in 1972 a water allocation agreement for the Orontes River was signed between the two countries. However, this agreement never came into force due to bad political climate in both countries. In 1994, Syria and Lebanon signed another agreement for sharing the Orontes water resources and again Turkey was excluded from the negotiation process. Turkey was very critical to this agreement, while the Syrian position was very clear in not recognizing Hatay (Iskandaronatt) as a Turkish region. The same Syrian position was again reported during negotiations between Turkey, Syria and Iraq in the early

1980s over the Euphrates River. During these negotiations Turkey requested to include the Orontes River in the discussions. Again, the Turkish request was refused by Syria, motivated by its claim to Hatay (Iskandaronatt) as part of its own territory.

With the signing of the Adana Security Agreement between Turkey and Syria in 1988, the relations between the two countries started to change. This agreement opened up a good opportunity to build up a trust relationship between the two countries. The economic relations between the two states started to develop on a fast track and a Free Trade Agreement was signed in 2004 during the official visit of the Syrian President Bashar Assad to Turkey. Turkish authorities interpret the signing of the Free Trade Agreement as Syria's acknowledgment and recognition of Turkey's borders including the province of Hatay. Syria did not comment on these Turkish claims till recently, considering the Turkish claims as a misinterpretation of the signed agreement.

In December 2009, Syria and Turkey signed in Damascus 50 agreements including four Memoranda of Understanding related to water. One of these memorandums dealt with the Construction of the joint Orontes River "Friendship Dam". Costs of the dam were to be met by both countries. The project concerns the same dam as already previously proposed by Turkey in the 1950s during negotiation over the Syrian Ghab project. The Syrian position has changed after the collapse of the Zeizoon Dam, which killed more than 20 Syrians and flooded a wide area in Hatay. For this reason the agreement was accompanied by a side agreement for the installation and operation of modernized flow measuring stations that serve as early warning systems for flood protection.

Unfortunately, since 2011 the relations between the two countries have collapsed and the atmosphere of trust between the two states might be lost for a long time. Restoring the achieved progress will require huge efforts from both countries.

References

- Alakhrass O. (2014). Syria falls beneath the water poverty threshold, Workshop on Water Demand Business Management, Ministry of Water Resources, Arabic, published 28/08/2014. Available at: <http://www.aremnews.com/?id=59086> [accessed 23 December 2014].
- UNEP (2013). Arab Region: Atlas of Our Changing Environment. United Nations Environment Programme (UNEP), Nairobi, Kenya.
- ESCWA (2013). Inventory of Shared water Resources in Western Asia. Available at: <http://waterinventory.org/sites/waterinventory.org/files/00-Information-brochure-Water-Inventory-web.pdf>
- FAO (Aquastat) (2005). Syria profile, published April 2005. Available at: <http://www.fao.org/nr/water/aquastat/data/query/index.html> [accessed 6 October 2014].
- Haddad G., Széles I. and Zsarnóczai J.S. (2008). Water management development and agriculture in Syria. *Bull. of the Szent István Univ.*, Gödöllő.
- Jemmali H. and Sullivan C. (2012). Multidimensional analysis of water poverty in the MENA region, Springer online. Available at: <http://link.springer.com/article/10.1007%2Fs11205-012-0218-2>
- Palestinian Business Forum (2010). Syria is modernizing the Syrian irrigation sector to save water resources. Available at: <http://pbf.org.ps/site/?q=pages/prnt/1820/> سوريا-تتحول-إلى-الري- الحديث-لتوفير-الموارد-المائية [accessed 23/12/2014].
- Van Nice C., Lee J. and McGinley M. (2011). Meig's Maps of Arid and Semiarid Regions. Encyclopedia of Earth, published 29/07/2011, updated 03/08/2011. Available at: <http://www.eoearth.org/view/article/168410/> [accessed 5 October 2014].

Building efficient models of global governance

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This chapter is theoretical in nature and develops an innovative theoretical model of regional coordination to improve governance and compliance with global rules. It builds an innovative understanding of compliance and builds policy-relevant tools to improve the efficiency of global governance.

International regulatory agreements have become a central mode of governance across policy sectors. In an increasingly connected world the coordination of decisions has become crucial for the conduction of policy-making. Coordinating policy choices and agreeing on international regulatory frameworks can enable states to achieve specific goals, such as reducing environmental damage, protecting refugee rights and guaranteeing free-flows of international trade. Collective agreements also facilitate burden sharing and, if a stable equilibrium is achieved, may reduce the cost of action for rational states. Can a regional tier of governance provide a mechanism to improve the stability of the hydro-politics in the Orontes River Basin?

This chapter thus explores the role of the regional tier of governance as a determinant of compliance and opens the question to whether such model of governance can be applied to other regions of the world and across policy sectors. The regional tier model of governance is based on the delegation of enforcement and management powers to supranational institutions, the provision of access to legal mechanisms to private actors and the application

of international rules that are legally embedded in the regional organization. The argument holds that the regional tier of governance improves compliance with regional agreements. In addition, the regional tier of governance improves compliance with global rules as a side product of delegation and credible commitment at the regional level.

This theoretical model maintains that the regional mode of governance exercises an independent effect on states to ensure adherence to collective agreements. One may expect that states belonging to a regional tier of governance are, *a priori*, more likely to comply with international law than their non-regional tier dependant counterparts, given that these states have voluntarily committed to treaty requirements and regional regulations. Yet this thesis argues that the compliance record of member states with international agreements is not solely endogenous, but rather shaped by the regional tier of governance. After all, despite voluntary treaty ratification, even cooperative-minded states may be tempted to renege on their commitments and to rely on other players to bear the cost of action while enjoying the benefits of international regulations.

In addition, although member states' delegation of enforcement and management powers to supranational institutions is shaped by utility maximizing strategies, these transfers may lead to unintended consequences. Indeed, through path dependence, establishing an efficient regional tier of governance improves compliance with global rules. In the case of the EU for example, compliance with global rules through the regional tier follows a two-stage process. Firstly, EU member states collectively sign-up to international agreements. Secondly, once adopted, these global rules become legally embedded in the rules of the regional tier that locks states into compliance with global rules they cannot easily opt-out from. As such, EU member states are expected to perform better than comparable non-EU member states in terms of compliance with similarly costly agreements. In contrast, non-member states are stand-alone and can more easily opt-out from their commitment.

1. The puzzle: why do states comply?

As a result of the interconnectedness of contemporary economic,

environmental, and development policy domains, states must not only trust that all involved states will comply with agreed-upon policies, but there must be a high level of predictability that compliance will result. The management of global policy issues thus necessitates credible and efficient institutions to enable coordinated and cooperative policy-making.

Encouraged by observed levels of compliance, growing international regulatory models of coordination have been adopted worldwide. The European Union delivers a significant set of regulations both in quantitative and qualitative terms. Emerging as a regulatory state (Majone, 1996), the EU has established a supranational model of policy-making and governance. This model is based on a detailed legislative framework as well as enforcing institutional devices, such as the European Court of Justice and the European Commission. Other international regimes facilitate and constrain state relations at the supranational level in salient policy areas. For instance, the United Nations has succeeded in mapping the opportunities and constraints regulating environmental policies and transboundary water policies, while human rights regulations are increasingly decided at the supranational level. International regulatory agreements between states have thus become a central mode of governance and policy-making in supranational political systems. The international regulatory system's credibility and efficiency is a product of their ability to achieve satisfactory levels of compliance with international agreements and to reach a stable equilibrium (Moravcsik, 1998).

However, despite the high cost of bargaining and the careful design of effective and detailed regulatory agreements, states, at times, fail to comply. Problems of defection exist across policy sectors. Scholars are divided on which factors shape compliance and the institutional mechanisms required to solve enforcement problems. Rational choice institutionalism focuses on the functional role of institutional designs and the importance of sanctions and penalties to push states to comply. Within this theoretical framework, enforcement theorists understand non-compliance as a deliberate choice by a rational state to violate treaties after weighing the costs and benefits of alternative behaviors. On the other hand, management theorists interpret infringement as a result of national government capacity-limitation and thus privilege such tools as capacity building and monitoring, rather than coercive

measures, to ensure compliance (Tallberg, 2002). The enforcement school and the management school drive the central debate in the literature on national compliance. Regarded as competing frameworks in both theory and practice, they arise from different assumptions concerning the nature of law and state behavioral choices, and embrace different approaches to promote compliance with international regulatory regimes (Tallberg, 2002). The enforcement and management approaches alone, however, do not provide a complete picture of the compliance patterns achieved by governments.

Constructivist theories have also analyzed the importance of shared norms and identities in creating cooperative behaviors. Through the process of bargaining and socialization at the supranational level, actors involved in the policy-making process can build a shared commitment to the rule of law and the specific norms it entails. Furthermore, procedural legitimacy can arise from supranational coordination and create a compliance pull that limits defection. Social learning and persuasion leads to logic of appropriateness and improved compliance rates (Börzel et al., 2004; Checkel, 2001; Finnemore and Toppe, 2001).

However, even among cooperative-minded states, defection is likely to occur. Full compliance is impossible to achieve in equilibrium. In real-world settings shirking is the norm. Full compliance is plausible if requirements that do not involve a departure from the status quo, would have taken place even in the absence of the international law or when the punishments are disproportionate to the crime. In repeated settings, under plausible conditions of monitoring and despite cooperative motivations, any equilibrium implies deviation from full compliance (Bednar, 2006). While full compliance cannot be an efficient equilibrium, degrees of compliance may result and are shaped by specific conditions, such as institutional settings. Improved cooperation is thus possible and has important implications for legal and institutional design. Instead of aiming to reach an impossible or overly costly equilibrium of full compliance, effective institutional designs should improve compliance. In the case of the Orontes River, regional stability and cooperation would improve the implementation of United Nations regional and international agreements for water management.

This chapter aims to contribute to the current research on state compliance

by proposing a model of governance that seeks to bridge the gaps among enforcement, management and constructivist theories. It argues that the regional tier of governance can improve compliance.

The regional tier model of governance, as developed in this chapter embeds international agreements in the rule of the regional organization, thereby forcing member states to adhere to a whole legislative package while raising the difficulty of defection. Substantive discretion has also been granted to supranational institutions to ensure that states credibly commit to policies. Establishing an efficient regional model of governance benefits utility maximizing member states and helps overcome collective action problems at the regional level. In turn, through path dependence, the process of credible regional level delegation improves compliance with international agreements.

2. The regional tier and regulatory regime efficiency

In the context of growing interstate cooperation, it is crucial for architects of international models of governance to understand why states comply and to be able to explain variation in the timing and quality of implementation. Problems in implementation are a source of pressing concern for politicians. The application of desired actions by agents and bureaucratic structures will have determinant implications for the governance and credibility of supranational political systems.

In order to manage increasingly integrated economies, regional models of coordination have expanded worldwide.

The extent to which the regional tier model of governance, analyzed throughout this chapter, may be replicated in the Orontes River region still requires further research on converging policy preferences and the impact of increased economic integration on the strategic choice to delegate decision-making competencies and enforcement powers at the regional level (Hix, 2010; Kahler, 2010). However if the regional tier model of governance as established in the EU efficiently improves compliance, this research could provide valuable implication for the establishment of functional institutional designs outside the EU borders.

Even if institutional variation occurs, the EU regional tier can provide valuable insights into building regional models of governance outside EU borders, especially with regards to institutional design and regime efficiency. Simply put, establishing a regional tier of governance improves compliance. The regional tier locks states into complying with a whole legislative package while limiting their ability to opt-out. In the absence of a regional tier, compliance patterns are more varied among similarly cooperative-minded states in spite of having similar levels of institutional capacities to the EU member states.

2.1 Theoretical assumptions

The assumptions underpinning this research are the following:

1. States are rational players. They will join international regulatory agreements if they provide an arena to maximize their utility. The utility derived from international regulatory agreements may range from economic gains and facilitated coordination, to burden-sharing and reducing the uncertainty of the future. However, joining international regulatory agreements is costly. It can impose either sharp departures from the status quo or specific national preferences as well as entail burdensome legislative implementation. States delegate national sovereignty to the international level if it results in economic gains and the advancement of policy preferences. In order for international regulatory agreements and supranational models of governance to persist, they have to maintain the equation in favor of rational states. That is, the long-term benefits states derive must exceed the costs of participation and compliance.
2. International regulatory agreements are a mode of governance and provide coordination at the international level. Yet collective action and coordination problems plague the game conducted among utility maximizing players at the supranational level, including among the most cooperative-minded states. The outcome of a Prisoners' dilemma is sub-optimal since both players have an incentive to defect. In coordination games, the outcome is contingent on the other players' decisions. An increase in the number of players heightens the need for rule clarification and mechanisms to facilitate coordination and bargaining. Collective

agreements at the international level thus require the establishment of functional institutions to ease coordination and diminish states' incentives to defect. Satisfactory levels of compliance with costly requirements are plausible in equilibrium if, and only if, mechanisms are in place both to raise the cost of non-compliance and to ensure that the rules of the game and strategic moves of rational players are transparent and monitored. Consequently, institutions in international regulatory settings are functional and sustain the credibility and efficiency of regulatory regime.

3. Even among cooperative-minded states full compliance is impossible to achieve in equilibrium. Regulatory regimes are prone to the standard problem of defection. Other reasons for non-compliance include a lack of resources and misinterpretation of treaty requirements. As such, functional institutional frameworks should not seek to achieve full compliance, but rather to improve compliance rates.
4. In the process of delegation, cooperation among states can improve the legitimacy of agreed-upon regulatory frameworks and push for further compliance. The regional tier not only provides additional avenues for enforcement and managerial mechanisms, but it can also improve the legitimacy of agreed regulatory frameworks. Regional level functional institutions established among similarly minded states can create a set of norms, or shared ideas, which, in turn, modify the preferences of states and their subsequent behavior towards agreed policies. Allowing non-state actors to participate in the policy-making process clarifies international regulations and can create a set of shared norms and legitimate regulatory output that then pulls states into further compliance.

In sum, institutions are thus the central element that enables states to behave in an orderly and coordinated way, and lead in a shift from a state of anarchy to global governance. Yet the following questions remain. If institutions are functional, then what mechanisms are the most efficient to make states comply? What models of delegation are available to overcome national level resource gaps, improve legitimate regulatory outputs and reduce states' likelihood to defect? In response, this research's theoretical core is that it is crucial to combine constructivism, enforcement and management mechanisms to improve compliance rates to international regulations.

3. Theoretical model: the regional tier of governance and compliance

3.1 Functional institutional design: enforcement mechanisms

States anticipate the costly nature of specific regulatory frameworks and will decide to delegate more or less power to functional institutions to protect their interests. This decision to coordinate policy-making at the international level may be driven by shared interests and norms. Coordinated action through international regulatory systems can lead to anticipated gains through burden-sharing and cooperation. However, despite anticipated gains and adaptable regulatory systems, the temptation to free-ride remains high at all levels of delegation and can be overcome through adequate sanction mechanisms, such as penalties, and active judicial bodies able to impose credible threats. Sanction mechanisms will reduce the likelihood of states evading their commitments. This is especially true when international regulatory commitments are costly: in such cases, states are more likely to fail to comply. Hence, sanction mechanisms are crucial to achieve compliance rates that will preserve the existing regulatory framework and not undermine the efficiency and credibility of coordinated attempts to deliver international policies. Sharing the burden of compliance decreases its cost relative to that of non-compliance. The long-term benefits provided by sustained cooperation will create an incentive for states to maintain the game and adhere to costly regulations.

3.2 Improving the efficiency of regulatory regimes: combining enforcement and management tools

The efficiency of international regulatory regimes can be further improved through a combination of enforcement and management mechanisms (Tallberg, 2002). For instance, regulatory regimes are not complete if they do not provide paths to help states deal with the complexity of implementing new regulations. Existing domestic challenges and adaptation costs that accompany new legislation may hinder domestic compliance. Sanction mechanisms alone would be traumatic and counter-productive in cases where rule ambiguity, or lack of expertise and financial resources, may undermine the capacity of

states to comply efficiently. As such, while management mechanisms fail to deter the temptation of states to free ride in collective action settings, they are a crucial element to improve compliance.

Positive determinants, such as financial assistance, international recognition, technology and resource sharing can also increase the benefits of compliance. Functional mechanisms and efficient models of governance do not operate as a stand-alone system; rather, they have to adapt their operational input to the international and/or domestic political or economic context. If, for example, the rise of a given technology can increase the benefits of compliance, then technological transfer and assistance are required to pull member states into compliance.

Thus, the combination of enforcement and management mechanisms as paths to compliance enable the establishment of an efficient and adaptable mode of governance. The appropriate tools will be adopted in coherence with the domestic and international context, as well as the specific cost of compliance.

3.3 The regional tier of governance: enforcement, management and constructivism

Specific conditions are necessary for regional integration to succeed. The demand for the regional tier is derived from the need to reduce transaction costs and to obtain a solution to the coordination problems regional integration can generate. On the demand side, states' willingness and displays of leadership to commit credibly and to delegate sovereignty to the supranational level are conditions to successful regional integration (Mattli, 1999).

The concept of regional tier as developed requires three institutional set-ups:

- a. Delegation of enforcement and management powers to supranational institutions.
- b. Access for private actors to supranational legal mechanisms.
- c. International rules legally embedded in the rules of the regional organization.

Once the regional tier is adopted, it can solve coordination problems. In addition, a regional tier opens the gate at multiple levels to non-state actors

to agitate for compliance, as well as to ensure enforcement and management mechanisms are in place. Finally, if the process of collective bargaining and policy-making involves all sets of state and non-state actors, it may lead to a legitimate legislative output. In turn, this outcome pulls states into levels of compliance that are higher than what would have been achieved in the absence of a regional tier.

Granting access to private actors to legal mechanisms, pressure groups, NGOs, strong economic actors or civil society may push states to comply. Through the regional tier of governance, lobbying can occur through multiple avenues, ranging from the domestic, regional and international levels. Even if the state does not have an institutionalized system of coordination, the regional tier provides an additional avenue for non-state actors to participate in the model of governance and compliance system.

If a specific regulation is contrary to the interests of a powerful group, then states may find it too costly to comply and fail to do so. Delegation of enforcement and management powers can transfer the responsibility of guaranteeing compliance to actors beyond the domestic level. Opening the gates of judicial mechanisms to civil society and national courts also enables cases of non-compliance to be detected through “fire-alarm” and “police patrol” mechanisms, which involve non-state actors at the domestic, regional and international level.

In addition, a regional level of cooperation can increase the regulatory output’s perceived legitimacy. Opening the policy-making process to non-state actors, combined with negotiation at an additional level of coordination, can lead to the creation of a common identity and norms. Shared norms may shift the preferences of states and create a pull for compliance at the domestic level. States and non-state actors may value the rule of law and its detailed requirements if the regulatory regime is considered legitimate.

Players may also value sustaining the regional level of cooperation, which creates an incentive to play the game and maintains the efficiency and credibility of the regime through compliance. The existence of a regional tier and the process of socialization may also foster a dynamic whereby states are willing to delegate more sovereignty than would ever have been achieved otherwise. Proof that the regulatory system is efficient and that member states

are willing to play the game produces a climate of trust and cooperation that enables the establishment of costly regulations.

4. Conclusion

A regional tier will improve the efficiency of international regulatory agreements since it adds an additional level of commitment, rule-clarification and sanction mechanisms to achieve domestic level compliance with global and regional rules. In the case of the Orontes River, if the model of governance at the regional level adheres to international agreements following a collective consultation process, then states are more likely to comply with these agreements than if they had signed them alone. Not only does regional integration guarantee the costs of compliance are shared, but it strengthens the level of commitment of member states.

In short, utility-maximizing states are less likely to comply with regional and global rules if they have not joined a regional tier of governance. If a regional tier is successfully established, with all conditions of delegation and access in place, states can be locked into compliance with a whole legislative package. The legitimacy of the legislative output and the participation of non-state actors will also increase state compliance. Therefore, the regional tier is an efficient model of governance to improve compliance with regional agreements and, as a side product of credible commitment, global rules.

As illustrated in Figure 1, the additional supranational tier should improve the compliance performance of member states with global and regional rules. If an additional set of delegation is in place, then the compliance mechanisms are multiplied at the regional level to lock states into compliance with a whole legislative package.

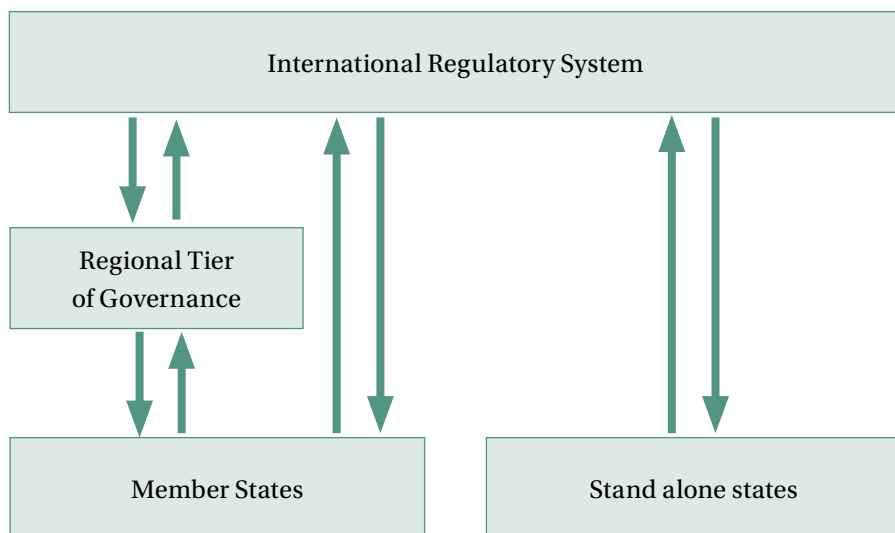


Figure 1: Systems of compliance: international, regional and domestic level of analysis

In sum, the establishment of a regional tier of governance can lead member states to adopt costly agreements while also establishing a set of functional institutional designs that lock states into compliance with a whole legislative output. The additional regional layer can help improve the efficiency of international regulatory frameworks and compliance with global rules; however, the establishment of such institutional mechanisms is ultimately dependent on the willingness of states to commit.

Further research is necessary to evaluate the extent to which a regional tier of governance is replicable across regional specificities and identify the mechanisms that have led to existing models of regional delegation and coordination.

References

- Bednar J. (2006). Is full Compliance Possible? Conditions for Shirking with Imperfect Monitoring and Continuous Action Spaces, Department of Political Science, University of Michigan.
- Börzel T.A., Hofmann T., Sprungk S. (2004). Why do States not Obey the Law? Non Compliance in the European Union, Paper prepared for presentation at Leiden.
- Chayes A. and Chayes A.H. (1993). On Compliance. *International Organization* 47(2): 175-205.
- Checkel J. (2001). Why Comply? Social Learning and European Identity Change. *International Organization* 55(3): 553-588.
- Finnemore M. and Toppe S.J. (2001). Alternatives to Legalization: Richer Views of Laws and Politics. *International Organization* 55(3): 743-758.
- Hix S. (2005). The Political System of the European Union, New York, Palgrave.
- Kahler M. (2010). Regional integration in an Era of Globalization and Crisis: Asia in Comparative Context, Paper prepared for the 2010 annual meeting of the American Political Science Association.
- Majone G. (1996). The Rise of the Regulatory State in Europe. *West European Politics* 17(3): 78-122.
- Mattli W. (1999). The Logic of Regional Integration: Europe and Beyond, Cambridge England, Cambridge University Press.
- Moravcsik A. (1998). The Choice for Europe, Social Purpose and State Power from Messina to Maastricht, New York, Cornell University Press.
- Simmons B. (1998). Compliance with International Agreements. *Annual Review of Political Science* 1: 75-93.
- Tallberg J. (2002). Delegation to Supranational Institutions: Why, How and with What Consequences? *West European Politics* 25(1): 23-46.
- Weingast B. (1989). The Political Institutions of representative government. *Journal of Institutional and Theoretical Economics* 145: 693-703.



PART II

New technology tools for water management of the Orontes River Basin

Water resources and security challenges in the Orontes River Basin

GEORGES COMAIR, DAVID EATON AND DAENE MCKINNEY

1. Introduction

The Orontes River Basin is shared among Lebanon, Syria, and Turkey. These waters are a critical resource for the development of these co-riparians in terms of both water and national security. The total length of the Orontes is about 448 km, of which 325 km flows in Syria, 88 km in Turkey and 35 km in Lebanon (Kibaroglu et al., 2011).

The sources of the river, the Al-Labweh, Ain Zarka and Daffash springs, are located in the northern Bekaa region of Lebanon at 400 m above sea level. The Orontes defines 31 km of the Syrian-Turkish border and discharges into the Mediterranean Sea in the Province of Hatay in Turkey, where its average annual flow potential including its tributaries (Afrin and Karasu) varies between 2.4 and 2.8 billion cubic meters (BCM) (75.7 to 88.3 m³/sec) (ESCWA, 1996; Kibaroglu et al., 2011). The Orontes is heavily developed in Syria (90%) for irrigation and industrial water uses. Both Turkey and Syria have taken unilateral steps to expand their irrigated areas within the basin.

Today, Lebanon uses much less water from the Orontes compared to Syria and Turkey, since domestic rivers such as the Litani River provide abundant resources. Lebanon was investing in infrastructure to use water from the Orontes, but since the diversion dam (Figure 1) was destroyed during the Israeli-



Figure 1: Diversion dam before the bombing © Georges Comair

Lebanese conflict in 2006, Lebanon has only been using groundwater in this region. Current water utilization is not equitable since Syria is using almost all of the water generated in the basin. Out of the $38 \text{ m}^3/\text{sec}$ that potentially can be used after the river leaves Syria, only a meager amount estimated at $3.8 \text{ m}^3/\text{sec}$ (10% of the natural flow) flows to Turkey from Syria.

In the Basins at Risk (BAR) project (Yoffe et al., 2003) the Orontes River Basin was identified as “at risk” because ongoing and future large development projects may result in water scarcity conflicts (Homer-Dixon, 1994). Today the Orontes Basin is also the scene of a major conflict which has caused a major damage to water infrastructure in the Syrian part of the basin. We can see clearly today that the Orontes Basin is the scene of an ongoing conflict in Syria and near the Syrian-Turkish border.



Figure 2: Diversion dam after the bombing © Georges Comair

2. The Orontes river system characteristics

2.1 Hydrology

The Orontes River originates in Lebanon and flows north through Syria to the province of Hatay, Turkey, discharging into the Mediterranean. Snowfalls in Lebanon and groundwater flow from large karstic springs contribute to the streamflow of the Orontes. Its main tributaries are the Afrin and the Karasu Rivers. The Karasu River (120 km) flows through Turkey and forms the border between Turkey and Syria; its mean annual flow is about 39 MCM/year. The Afrin River (131 km) originates in the southern slopes of the Kartal Mountains in the Gaziantep Province, Turkey, and crosses Syrian territory before re-entering Turkey and discharging into Lake Amik (Kibaroglu et al., 2011) (Figure 4); its mean annual flow is about 60 MCM/year. Figure 4 also shows in red the 2 main irrigation schemes in the Ghab valley and the Amik plain.



Figure 3: The Orontes River in Lebanon © Georges Comair

The catchment area of the basin in each country is shown in Table 1 and the tributary basin characteristics are shown in Table 2. The catchment areas were determined using the geodatabase that is described in Part II, Chapter 4.

Countries	Catchment area (km ²)	Catchment percent (%)
Lebanon	2,209	9
Syria	16,979	69
Turkey	5,556	22
Total	24,745	100

Table 1: Calculated catchment area per riparian country (source: the authors)

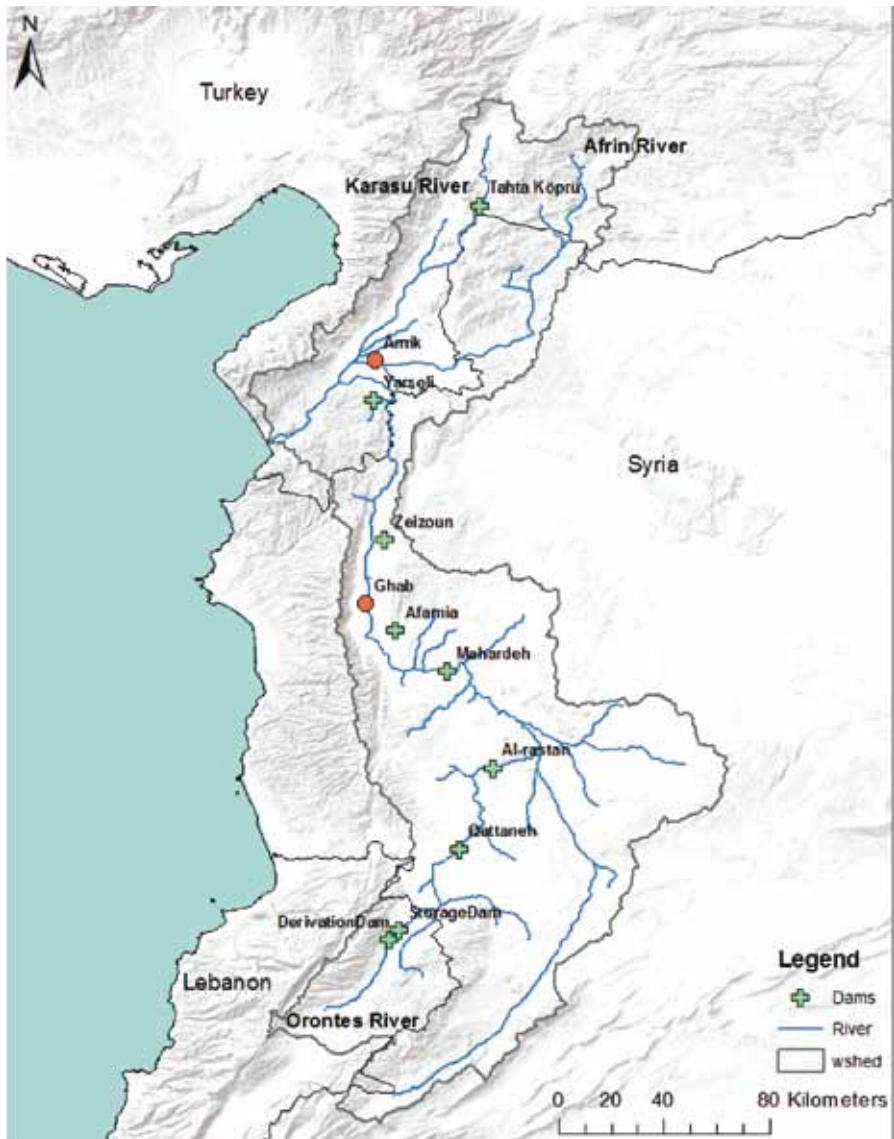


Figure 4: The Orontes Basin boundaries, drainage system and dams (red dots indicate the main irrigation areas) © Georges Comair

Characteristics	Afrin	Karasu
Area of the basin in Turkey (km ²)	2,234.4	2,863.44
Area of the basin in Syria (km ²)	1,685.6	885.6
Total basin area (km ²)	3,920	2,952
Mean annual flow (BCM)	0.6	0.4

Table 2: Afrin and Karasu basin characteristics (source: the authors)

Highlands situated on both sides of the rift valley and karstic springs located at 690 m in the Bekaa valley of Lebanon contribute runoff to the river and its tributaries. Precipitation on the western mountains of Turkey varies from 600 to 1500 mm/year. On the eastern catchment (Lebanon), precipitation rates are lower varying from 400 to 600 mm/year (ESCWA, 1996). The highest annual evapotranspiration rates occur in the Syrian part of the basin and range from 1,200 to 2,000 mm (Kibaroglu et al., 2011). Due to these characteristics, the eastern tributaries are all ephemeral streams (ESCWA, 1996).

Groundwater contributes to approximately 90% of the total flow of the Orontes. Once reaching Syria, the river enters the Qattineh reservoir, where it is fed by 4 springs with a total discharge of 2.25 m³/sec (ESCWA, 1996). 50% of this flow comes from springs discharging from carbonate massifs in Lebanon and Syria 1.2 BCM/year (37.84 m³/sec). Approximately 1.3 BCM/year (41 m³/sec) can be potentially generated in Turkey from the combined flows of the Afrin and Karasu Rivers (Kibaroglu et al., 2005). Minimum and maximum discharges have been reported to range from 10 to 400 m³/sec (ESCWA, 1996; Kibaroglu et al., 2005). The discharges recorded from the streamflow gauges in the Hermel area of Lebanon draining about 1,240 km² and in Al Qusayr in Syria draining 1,890 km² shows that the Orontes flow is entirely fed by groundwater during dry years and summer months.

The water from almost all reaches of the river is not considered suitable for domestic and irrigation purposes, mainly due to the high concentration of nutrients and TDS (ranging from 400 to 930 ppm). Despite this, six reservoirs regulate the Orontes' flow that is used for irrigation, water supply and industry (ESCWA, 1996). The total capacity of the Qattineh, Al-Rastan and Mahardeh

reservoirs are 200 MCM, 224 MCM and 50 MCM respectively (Kibaroglu et al., 2011) (Figure 4). In 1996, the Zeizoun embankment dam was built in Syria to divert and store about 70 MCM of water from the Orontes River (Figure 4) for irrigation purposes, however the dam collapsed in 2002 due to structural failure and is being rebuilt today (2014).

All of these reservoirs are subject to eutrophication. The middle and lower reaches of the Orontes are considered to have the highest pollution levels (ESCWA, 1996).

Table 3 shows a summary of the springs and river flows. Some values were converted from BCM/year to m³/sec depending on the reference, therefore values can deviate slightly from the exact measured flow.

Reach	Country	Number of Springs	Total discharge (m ³ /sec)	Country Percentage (%)
Headwaters	Lebanon	3	13.20	
Subtotal Lebanon			13.20	15
Upper reach	Syria	4	2.25	
Hama-Mhardeh	Syria	7	0.45	
Chizer spring	Syria	1	6.42	
Achorreh	Syria	6	2.27	
West Ghab	Syria	19	3.9	
East Ghab	Syria	10	7.59	
Lower reach	Syria	4	2.24	
Afrin	Syria		9.78	
Subtotal Syria			35	39
Afrin	Turkey		18.92	
Karasu	Turkey		12.61	
Orontes reach			9.46	
Subtotal Turkey			41	46
Total			89.2	100

Table 3: Orontes springs and river discharge in Lebanon, Syria and Turkey for the period from 1931 to 2010 (adapted from: ESCWA, 1996 and Kibaroglu et al., 2011)

2.2 Historical overview of water usage

Historically, Turkey and Lebanon have used less water from the Orontes River than Syria. Turkish development of the Orontes River began in the early 1940s, when the General Directorate of State Hydraulic Works (DSI) drained the Amik area (lake and plain) (Figure 4). Lebanon is a relatively water rich country and does not rely on the Orontes River as the main source for irrigation. The Lebanese usage of the Orontes River was restrained to recreational use and pumping from groundwater to supply the population in the early 1900s.

In 1950, Syria requested the help from the World Bank to finance the Ghab Project development plan. This plan was designed to drain a marshy area of 32,000 ha. At first, the World Bank was concerned about the effects of this project on Lebanon and Turkey. Turkey objected to the plan claiming that the project would reduce summer flow in the Orontes River thereby constraining irrigation and the development of hydro-electric power plants. The World Bank disagreed and believed that controlling winter floods in the basin would be beneficial for all riparians and that summer flow would still be sufficient for irrigation of downstream areas (Kibaroglu et al., 2011). The implementation of the project started in 1958 and continued for ten years. The success of the land reclamation motivated farmers to emigrate from poor farmlands and to establish communities in the Ghab area (Caponera, 1993).

In 1962, Syria asked the assistance of the Netherlands Development Corporation (NEDECO) for planning the future development of the Orontes River. Engineers from both countries gathered with the aim of establishing several cooperative goals:

1. Development of a master plan for the Orontes River concerning water use and rights
2. Development of flood control mitigation plans
3. Revision of the NEDECO plan to consider the Turkish point of view
4. Starting a feasibility study for the construction of a dam near the Syrian-Turkish border
5. Establishing a joint committee to monitor streamflow and flood warning stations

Nonetheless, at the end of the meetings no agreement was reached. It is worth noting that this plan was conceptualized without consulting the Turkish side,

WATER RESOURCES AND SECURITY
CHALLENGES IN THE ORONTES RIVER BASIN

Region	Total area (ha)	Area currently irrigated (ha)	Actual water source	Total area for rehabilitation (ha)	Area to be irrigated by the project (ha)
Left river bank					
Hermel, Bouwayda, Qaser, Mansoura, Kawakh	3,924	549	Wells and direct pumping from the river	3,109	2,875
Hermel village and surroundings	683	376	Wells, springs of Ras el Mal	-	-
River banks	274	247		-	-
Total left bank	4,881	1,172		3,109	2,875
Right river bank					
Tal Aswad	555	389	Direct pumping from the river	422	390
Mar Maroun	686	-		652	603
Qaa-Wadi Khanzir	307	92	Direct pumping from the river	292	270
Qaa-Banjakiya	982	49	Laboueh springs and wells	933	863
Qaa-Baayoun	1,075	-		1,021	945
Ras Baalbek-el Sahel	817	-		776	718
Total right bank	4,422	530		4,096	3,789
Total	9,303	1,702		7,205	6,664

Table 4: Irrigated areas in phase 1 of the planned infrastructure works (source: the authors)

who considered that parts of the plan were not aligned with Turkish interests (Caponera, 1993).

2.3 Existing and planned irrigated areas in Lebanon

The total irrigated land area in the basin constitutes about 300,000 ha, with an annual water use of 2.8 BCM. According to the FAO about 58% of the irrigated land is located in Syria, 36% in Turkey and 6% in Lebanon.

Table 4 shows the current situation of irrigation on the Lebanese side of the Orontes Basin, as well as the proposed expansion of irrigated lands when the planned infrastructure projects based on bilateral agreements with Syria will be accomplished (see Part I, Chapter 1).

2.4 Risk assessment: how severe are the water security challenges in the Orontes Basin?

According to the BAR project, the Orontes Basin is considered a “category two region” where indicators and protests over water exist. Category one areas are those where current conflicts exist (such as the Jordan River Basin). Given the current situation in Syria, we believe that the status of the Orontes Basin can soon be shifted to a “category one region”, implying a higher risk for conflicts. This is currently seen at the Syrian-Lebanese and Syrian-Turkish borders where daily clashes are occurring in Lebanese and Turkish villages surrounding the Orontes River (Ghab, Kaa, Hatay province, etc).

Indicators of potential conflicts in transboundary rivers can be applied to the Orontes Basin: such as extreme changes in physical or institutional settings - a good example will be the future regime change in Syria if it were to occur. This institutional change will ultimately have an impact on the institutional mechanics and agreements in the region. Syrian opposition has stated many times that future agreements signed by the Bashar el Assad regime will be re-examined and will most likely be re-negotiated, including past agreements over transboundary rivers of Syria such as the Orontes River Agreement of 2002 with Lebanon, and the Tigris and Euphrates Rivers Agreement with Turkey. The new Syrian regime may wish to halt construction of the two dams upstream in Lebanon; including the change in water allocations (currently Lebanon has the right to divert 80 MCM). This will also include the GIS

database currently being developed by the two countries and the water rights on the transboundary aquifers of the Orontes Basin.

Once the current conflict is resolved, the three co-riparians sharing the Orontes Basin may meet in a constructive spirit and start new discussions on water resources management and sharing. Based on field visits and meetings with local farmers in Lebanon, increasing water availability will enable farmers to shift towards more economically valuable crops, and improve the overall agronomic sector and related activities. Future work should include water use in the crop production costs. However, the effects of climate change in the basin could be devastating and lead to a decrease in water availability of each country. The evapotranspiration and contribution of each country to annual discharge are shown in Figures 5 and 6:

Contribution to annual discharge

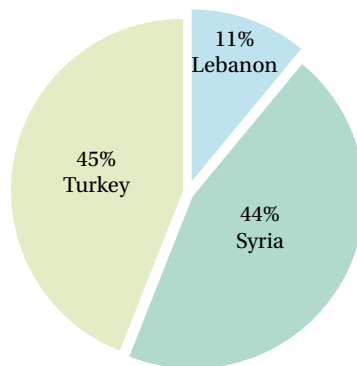


Figure 5: Riparian contribution to annual discharge of the Orontes River © Georges Comair

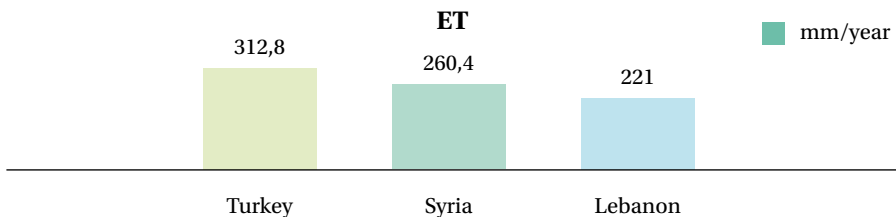


Figure 6: Evapotranspiration in the Orontes River Basin using the NASA satellite data © Georges Comair

Indicators such as temperature and ET as well as preliminary results from a hydrologic model developed for the study of the basin using the Water Evaluation and Planning (WEAP), shows that the area will most likely get warmer and precipitation and snow cover will decrease. Hydrologic models and water planning models are being used by the Ministry of Energy and Water in Lebanon using downscaling procedures, to evaluate the risk of climate change in the basin. These procedures, combined with checking forecasts against actual meteorological data from local measuring stations, can help generate local forecasts for the near term (15 to 35 years), the medium term (40 to 70 years) and long term above 90 years in the future.

References

- Caponera D. (1993). Legal aspects of transboundary river basins in the Middle East: The Al Asi (Orontes), the Jordan and the Nile. *Natural Resources Journal* XXLI(3): 629-663.
- ESCWA (Economic and Social Commission for Western Asia) (1996). Water Resources Assessment in the ESCWA Region Using Remote Sensing and GIS Techniques. Report, Beirut, United Nations-Economic and Social Commission for Western Asia, Print.
- Homer-Dixon T.F. (1994). Environmental Scarcities and Violent Conflict: Evidence From Cases. *International Security* 19: 5-40.
- Kibaroglu A., Klaphake A., Kramer A., Scheumann W., Carius A. (2005). Cooperation on Turkey's transboundary waters. Research report for the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety, Adelphi Research, Berlin.
- Kibaroglu A., Scheumann W. and Kramer A. (2011). Turkey's Water Policy: National Frameworks and International Cooperation, Springer, Berlin.
- Yoffe S., Wolf A.T. and Giordano M. (2003). Conflict and Cooperation Over International Freshwater Resources: Indicators of Basins at Risk. *Journal of the American Water Resources Association (JAWRA)* 39(5): 1109-1126.

Technical perspective of ICT as a tool for improved responsible management of the Orontes Basin

SIMONE SALA, GIOVANNI FORMENTIN AND ANDREA PORRO

Information and communication technology (ICT) have a great potential to improve water management and governance worldwide. ICT can indeed help in facilitating data collection as well as the structuring of such data into cohesive frameworks to be leveraged by key stakeholders of a water sector. The study presents the efforts undertaken by the Lebanese Ministry of Water and Energy in collaboration with the Italian Ministry of Foreign Affairs and the University of Milan. Experts from these three institutions strengthened the ICT infrastructure of the Lebanese Ministry to increase sustainability of water consumption in the basin and deployed also new technology solutions to stimulate water cooperation among national and international stakeholders.

1. ICT to support adaptation and improve water management in the Orontes River Basin in Lebanon

The Asian Development Bank (2007) stated that information and communication revolution had radical impacts on water, particularly thanks to the improvement of information storage, retrieval and exchange (Asian Development Bank, 2007). Many scientists and institutions acknowledge that ICT infrastructure is fundamental in order to enable a sustainable end-to-end

management water cycle (Tsoi, 2006). This paper provides a bird's eye view on the application of ICT to enhance institutional capacity for water resources management in Lebanon, with attention to mitigating local and international conflicts over access to and use of hydro resources.

More specifically, in 2007/2008 the General Directorate of Hydraulic and Electrical Resources of the Lebanese Ministry of Water and Energy (MEW-GDHER, Lebanon) started consulting with the Italian Ministry of Foreign Affairs and International Cooperation to identify innovative ways of improving the management of the national water resources. As a result, the Orontes River Basin was selected as a suitable area to test a comprehensive application of ICT aimed at improving the end-to-end management of water resources while supporting adaptation to climate change. The project was then implemented in two different steps: the former aimed at introducing new technologies for data collection, analysis and sharing; and the latter focused on building capacities of both technicians and policy makers. Following the initial consultation phase between MEW-GDHER and the experts from the Italian Ministry of Foreign Affairs and International Cooperation, the Centro Interuniversitario per la Cooperazione allo Sviluppo in campo Agricolo e Ambientale (CICSAA) was selected to cooperate in developing and implementing an ICT platform to improve the management of water resources in the Orontes River Basin. The institutions thus began cooperating with the specific goal of developing information tools aimed at understanding climate and anthropogenic driving forces of the water sector in Lebanon and planning possible management strategies.

The first activity conducted by CICSAA experts was the in-depth assessment of the technical capacities and Information and Communication Technologies available at MEW-GDHER. Specifically, a series of interviews were conducted with MEW-GDHER personnel and MEW-GDHER partners in order to identify the assets that MEW-GDHER was using to plan water management – thus including:

- IT-related hardware (e.g. servers, networks);
- Software tools (e.g. water simulation models);
- Datasets (meteorological data, water quantity and quality, water use);
- Equipment for collection of water data (e.g. water quality assessment probes, water flow discharge measurement systems data loggers);
- Equipment for the collection of agro-meteorological data (e.g. rain gauges);

- Expertise and know-how among MEW-GDHER personnel (e.g. ICT skills). The analysis allowed identifying existing gaps in the technical infrastructure being used by MEW-GDHER to monitor water resources and related variables as well as to plan and implement adequate management strategies.

A key element that was thoroughly considered was the availability of data related to those variables having a direct impact on water resources (i.e. climate, water quantity and quality, water consumption across different sectors) and instruments used by MEW-GDHER and partners to collect them. All the available data were gathered, assessed and integrated into a cartographic database that was made available to the MEW-GDHER. Collection and analysis of these data was conducted in concert with MEW-GDHER experts on water resources, geology, hydrology, as well as with GIS experts responsible for the digitalization of those data inside the organization. Historical flow data, first of all those derived from other projects carried out by MEW-GDHER and the Italian Ministry of Foreign Affairs and International Cooperation, were gathered, with particular reference to data developed by an Italian project supporting aquaculture (i.e. trout fish farming) along the Orontes River (Haliéus, 2008; Ceccarelli, 2010).

In addition, linkages with other institutions (either formally or informally recognized) carrying out monitoring and management of water resources were explored – so as to plan an inclusive strategy allowing the comprehensive information and operational management of local water resources. Within this framework institutions working in other ministries were selected as possible partner in the development of Decision Support System (DSS) for improved management of the Orontes River Basin. As defined by Sprague (1980) a DSS shows the following characteristics:

- “DSS tends to be aimed at the less well structured, underspecified problem that upper level managers typically face;
- DSS attempts to combine the use of models or analytic techniques with traditional data access and retrieval functions;
- DSS specifically focuses on features which make them easy to use by non-computer people in an interactive mode; and
- DSS emphasizes flexibility and adaptability to accommodate changes in the environment and the decision making approach of the user.”

2. Main outcomes

Selected experts from CICSAA contributed to the development of a strategy with MEW-GDHER aimed at expanding the understanding of the impact of the main driving forces on water resources of the Orontes River Basin. In order to respond to the MEW-GDHER needs, the following set of information and communication tools and products was developed:

- Geo-dataset integrating data on local agro-meteorology and water resources;
- Digital Elevation Model of the Orontes River Basin;
- Model of the groundwater system of the Orontes River Basin via MODFLOW software tool;
- Information system based on WEAP software tool for water planning and evaluation with regards to the Orontes River Basin.

2.1 Geo-dataset integrating data on local agro-meteorology and water resources

Instrumental to build all information tools and products was the development of a comprehensive data-bank with existing data and information layers related to the Orontes River Basin that were collected throughout project activities. In light of the existing data gap highlighted through this assessment, three additional weather stations were installed along the Orontes River Basin in 2010. The stations were installed in Fekha, Jabbouleh and Younine and have since been used to collect the main agro-meteorological parameters (i.e. wind direction, solar radiation, precipitation, wind speed, air temperature, relative humidity, dew point and air pressure). Thanks to the data provided by such stations it was possible to develop a climate dataset directly managed by the MEW. The agro-meteorology data collected until the end of project activities, although still insufficient to permit an assessment of rainfall and climate change trends, constitutes an important source of information that will be expanded through further data collection using the equipment provided by the project.

This dataset responded not only to the need of improving the knowledge of weather and climate dynamics in the Orontes River Basin, but provided MEW-

GDHER also with primary data - as the preliminary assessment had revealed that until that time it could only rely on secondary data from third-parties. The newly introduced weather stations were installed in the aforementioned locations in order to be complementary with those in use by the Lebanese Agricultural Research Institute (LARI) in the same area. A continuous and fruitful exchange of data and information between the working group, the MEW-GDHER staff and its partners was activated. Such activities are instrumental in the development of

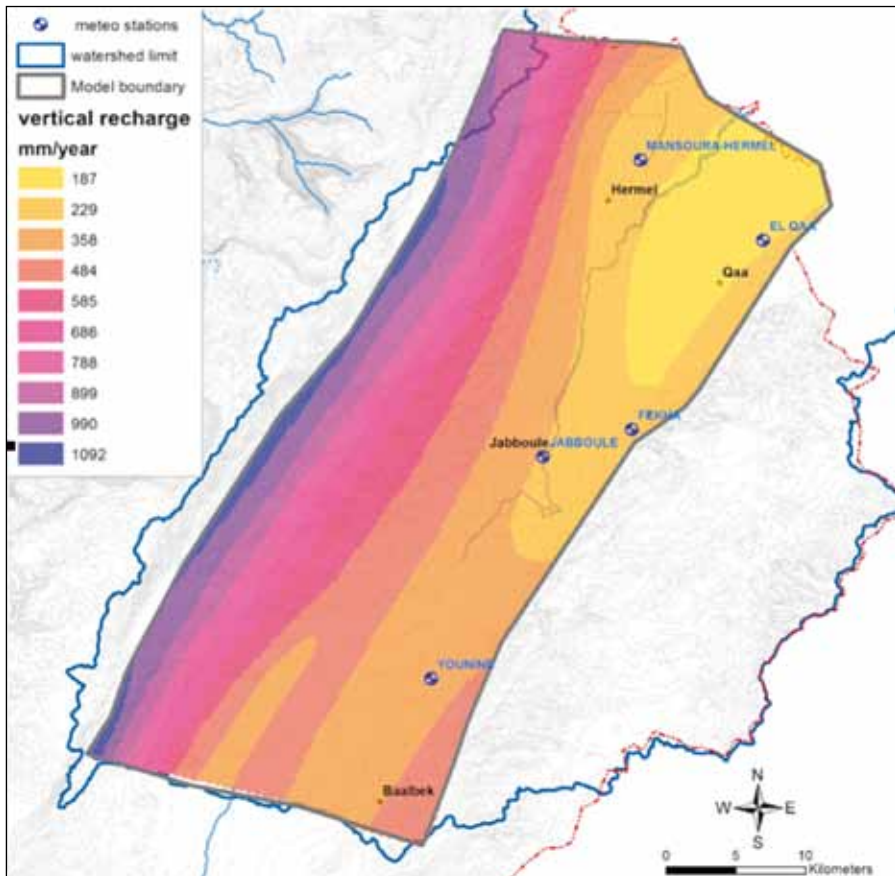


Figure 1: Map generated with data collected from meteorological stations installed in Younine, Jabbouleh and Fekha as well as data provided by MEW-GDHER partners

an integrated system of weather stations, which is preparatory to the construction – still in progress – of a comprehensive dataset of agro-meteorological parameters covering large portions of the Orontes River Basin.

A plan to collect data on water quantity and quality was developed with MEW-GDHER technicians. Demonstrations and hands-on training for the measurement of physical-chemical parameters of water resources along the Orontes River were organized. Due to the limited period of time available it was not possible to collect enough information to characterize the long-term cycle of water resources availability, but a monitoring program was consolidated by leveraging the tools that were provided by the project.

Finally, all existing data and information layers were standardized and integrated into a single and cohesive geo-dataset, with the main deficiency concerning the flow rate of the Orontes River. All data were later merged into a single geographic information package made available to MEW-GDHER and the public through a single package distributed on Google Earth (Figures 2a and 2b).

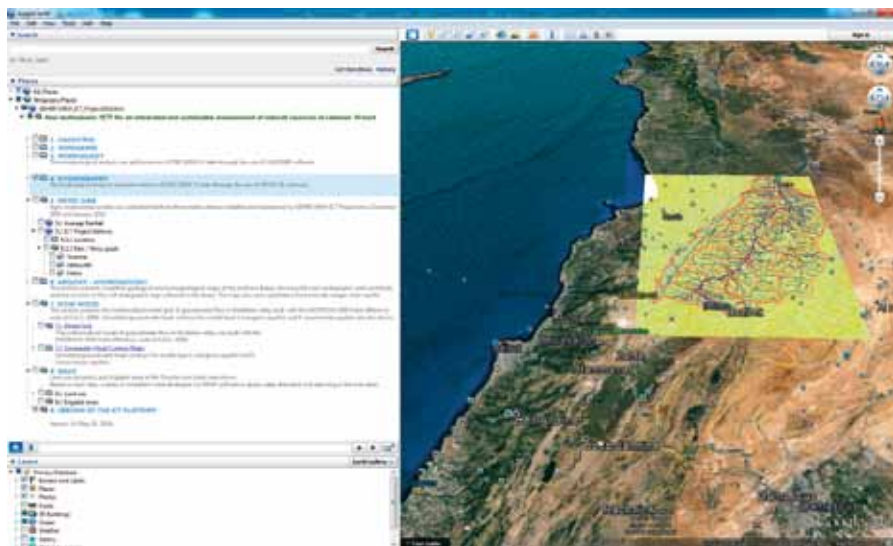


Figure 2a: Geo-information package distributed on Google Earth with all geographic information developed through project activities; in this snapshot the hydrography attributes are visible

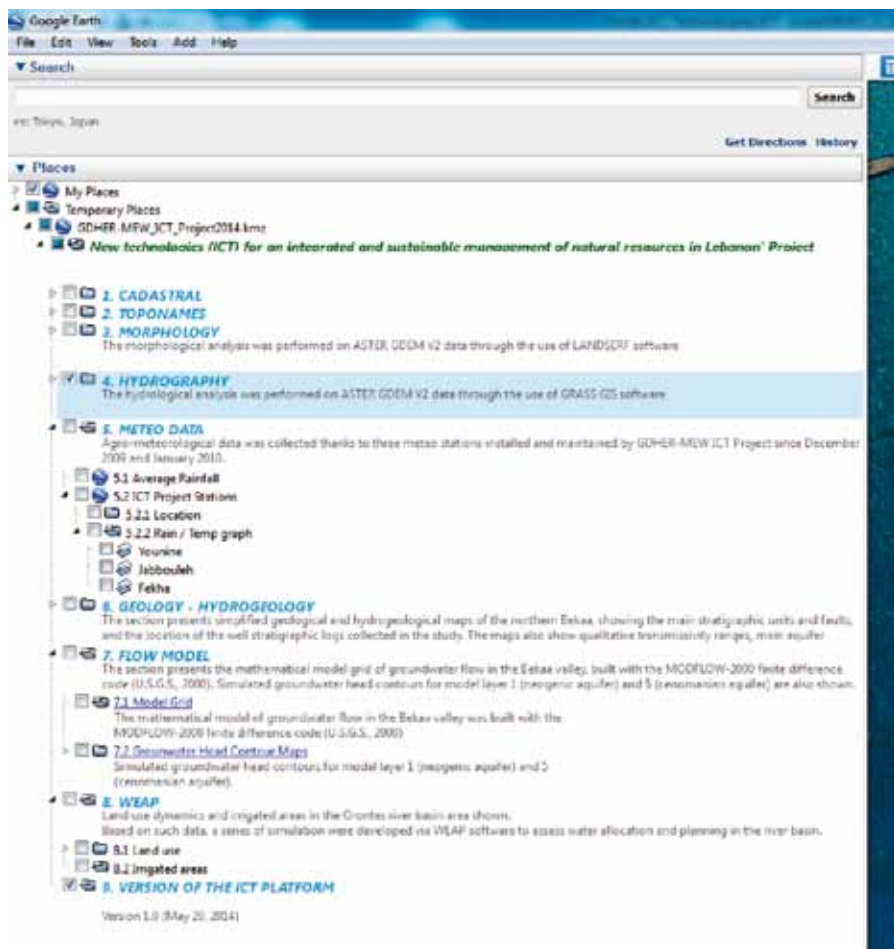


Figure 2b: Focus on the content of the geo-information package available in Figure 2a

2.2 Digital Elevation Model of the Orontes River Basin

The Digital Elevation Model (DEM) was composed by using free data from the Advanced Spaceborne Thermal Emission and Reflection Radiometer¹ (ASTER)

¹ <http://asterweb.jpl.nasa.gov/>

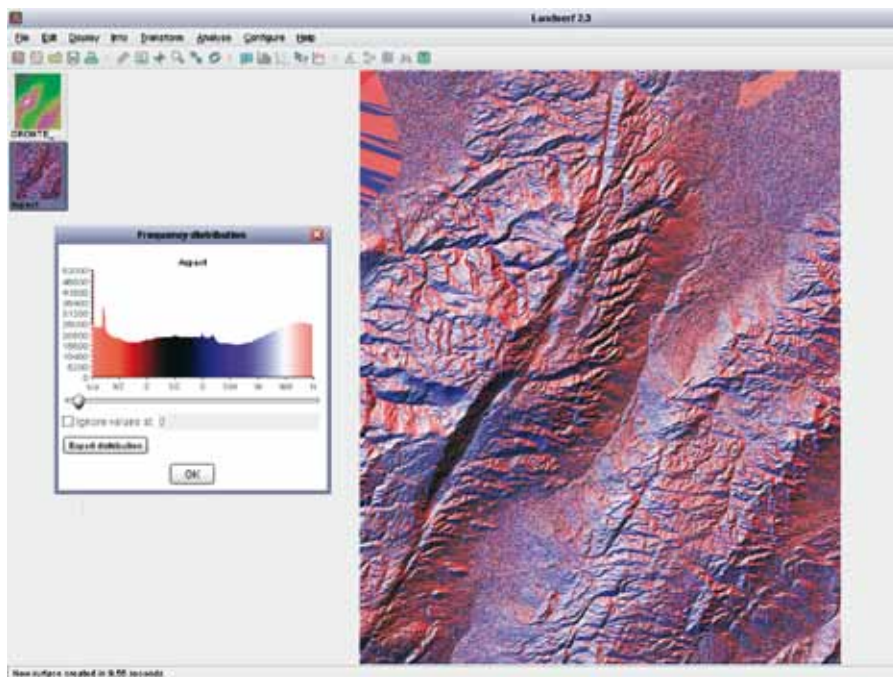


Figure 3: Void and pit removal in Landserf

Global Digital Elevation Model Version 2 (GDEM V2), which was jointly released by the Japanese Ministry of Economy, Trade and Industry (METI) and the United States National Aeronautics and Space Administration (NASA) on October 17, 2011. ASTER provides the opportunity for mapping especially at medium scales (1:100,000 - 1:50,000), and DEMs from ASTER remote sensing data are reliable sources for an interpretation of the macro- and mesorelief.

In particular, a number of 1,514,360 scenes (each about 60x60 km ground area) acquired in the period from March 2000 to August 2010 was used to generate the DEM. To handle the data and develop the DEM of the Orontes River Basin a combination of different Geographic Information System (GIS) software applications was used: *Landserf*² (version 2.3) for the visualization

² <http://www.landserf.org/>

TECHNICAL PERSPECTIVE OF ICT AS A TOOL FOR IMPROVED
RESPONSIBLE MANAGEMENT OF THE ORONTES BASIN

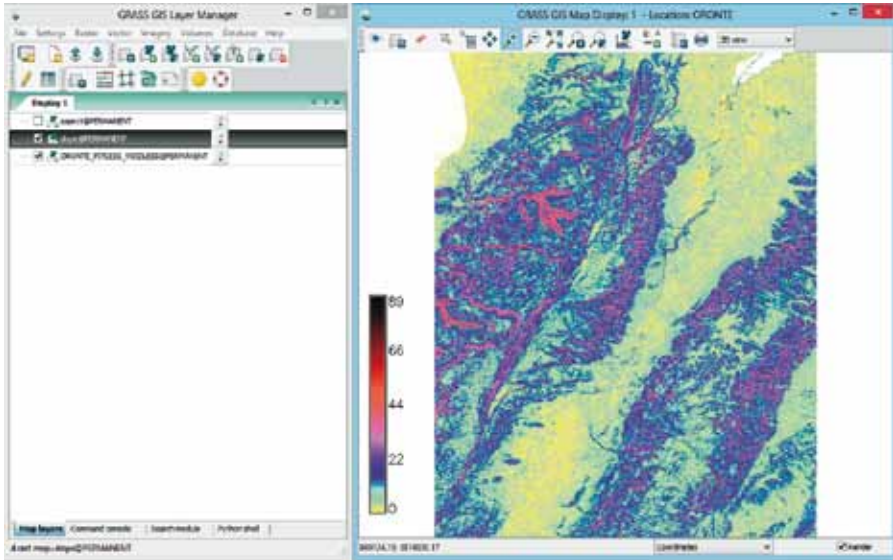


Figure 4: Hydrological analysis in GRASS

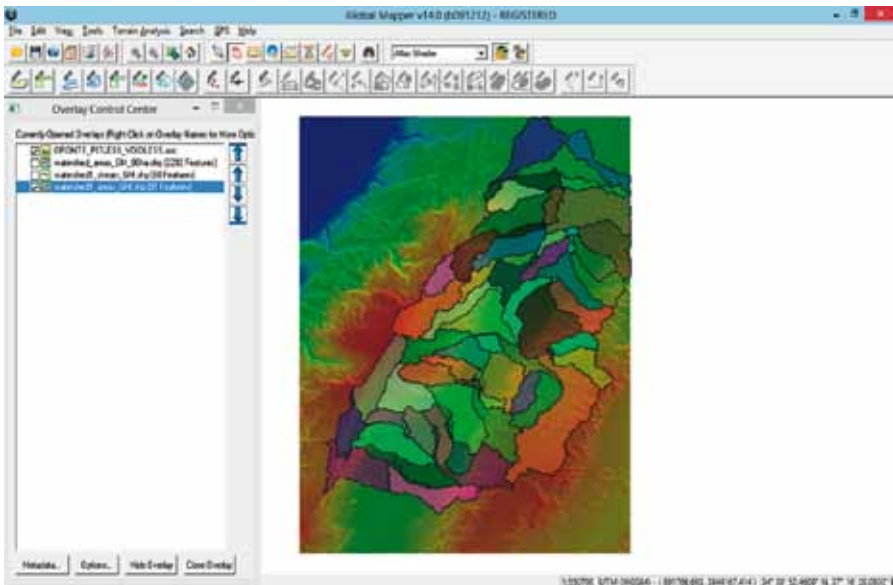


Figure 5: Drainage network analysis in Global Mapper

and analysis of surfaces (i.e. void and pit removal analysis; radian / meter curvature analysis), *GRASS*³ (version 6.4) and *Global Mapper*⁴ (version 14) for hydrological analysis. The resulting DEM covers land surfaces between 83 degrees north and 83 degrees south and it is composed of 22,600 1°x 1° tiles (reference to the WGS84/EGM96 geoid).

The DEM was key to delimit the Orontes watershed and to determine the flow directions throughout the entire basin at a detailed scale.

2.3 Model of the groundwater system of the Orontes River Basin using MODFLOW software tool

The study area includes the Lebanese sector of the Orontes river watershed basin, covering a total area of about 2,600 km² in the northern part of the Bekaa Valley. The watershed was identified through the hydrological analysis performed on the DEM. The geostructural framework of the region is related to the Levant Fault System whose major structures in the area of interest are represented by the Yammouneh and Serghaya Faults that show a main SSW–NNE direction. This regional fault system forms a restraining bend responsible for the large-scale fold structures and associated topographic elevations: the major anticline of Mount Lebanon, sub-parallel to the trace of the Yammouneh Fault, the complementary syncline to the east containing the Bekaa Valley, and the major anticlines of the Anti-Lebanon and Mount Hermon ranges (Develle et al., 2011; Daeron et al., 2007; Gomez et al., 2001).

On a smaller scale it is possible to identify two main additional fault systems, one with prevailing direction approximately parallel to the previously mentioned main structures (SSW–NNE) and a second having a dominant E–W direction. The presence of these fault systems results in the division of the study area into several segments that were also dislocated into uplifted and down dropped blocks. Within the Bekaa Valley there are also additional folds, lying exclusively to the east of the Yammouneh Fault, generally oriented oblique to its trace with N–S and NE–SW trending hinges.

³ <http://grass.osgeo.org/>

⁴ <http://www.bluemarblegeo.com/products/global-mapper.php>

The outcropping stratigraphic sequence consists mainly in shelf/basin carbonate rocks having an age ranging from Lower Cretaceous to Eocene, followed by a Neogenic-Quaternary continental sequence (Figure 6). The Cretaceous formations outcrop on the mountainside areas of Mount Lebanon and Anti-Lebanon and consist of limestones, dolomitic limestones with local interbedding of marls and marly limestones. The carbonate lithofacies

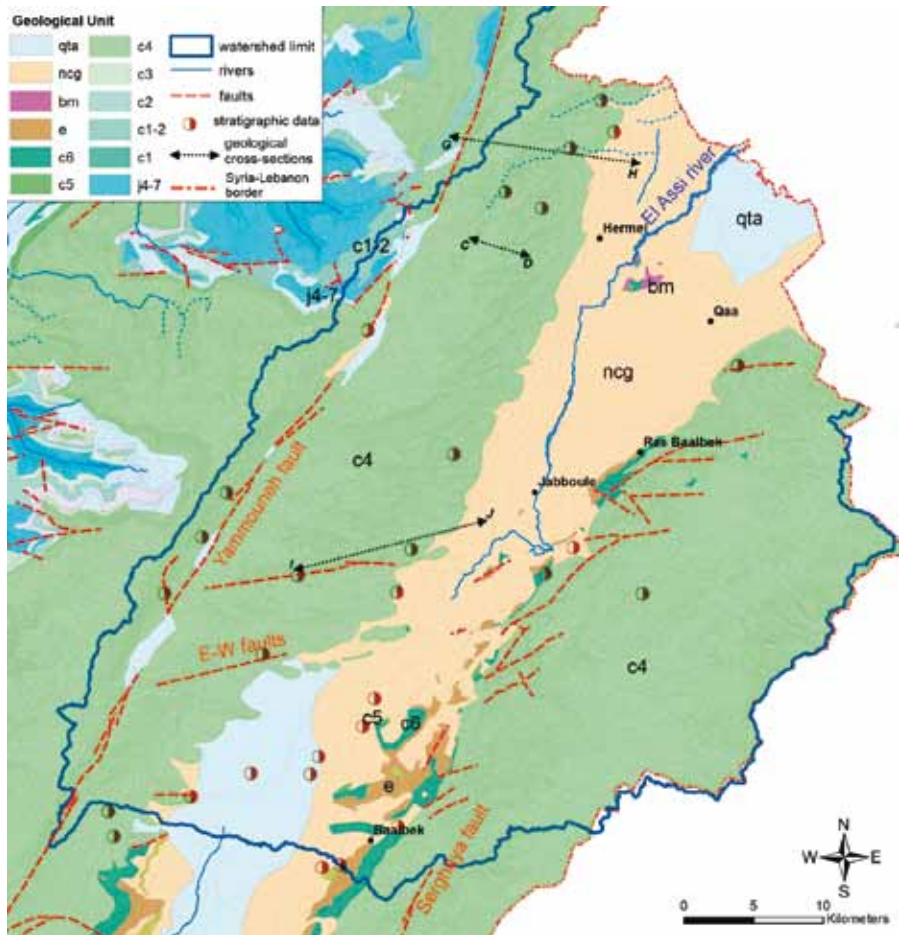


Figure 6: Geological map of the study area (source: the authors)

are generally characterized by widespread karstic landforms. The Neogenic continental sequence fills most of the depression of the Bekaa Valley and consists of an alternation of lacustrine limestones, marls and alluvial

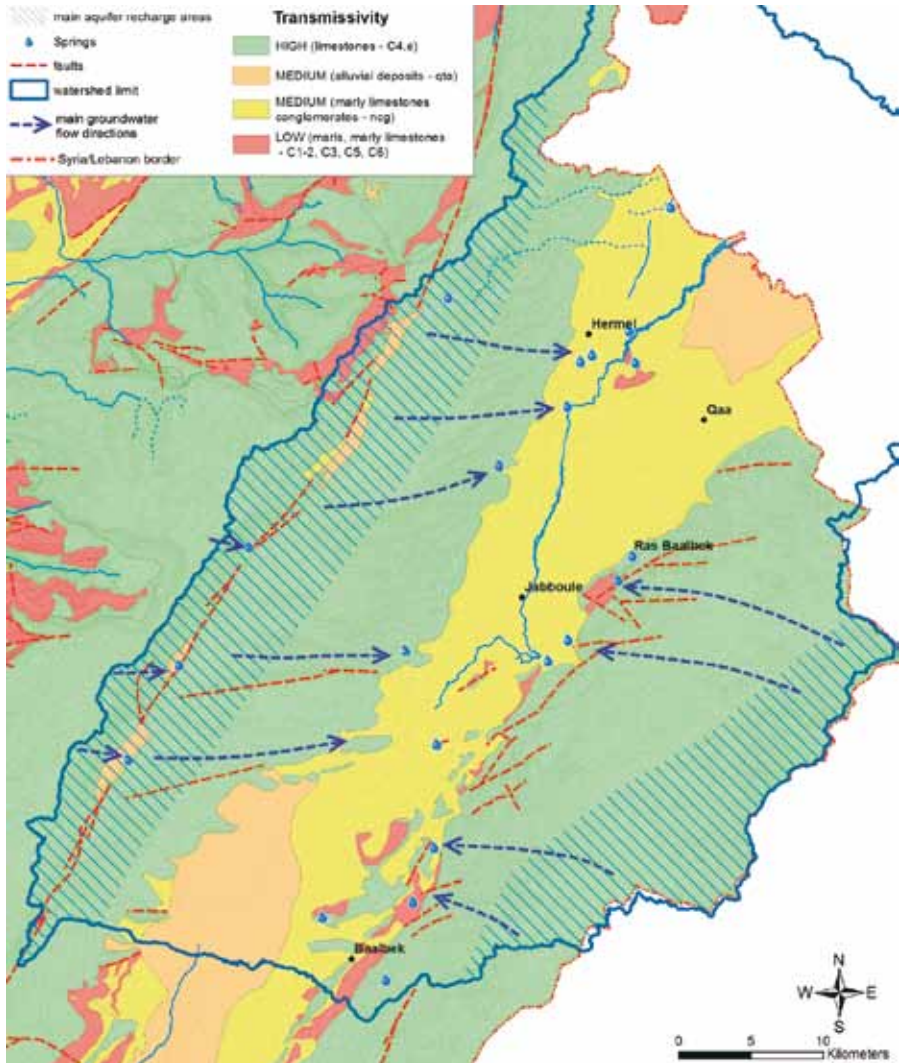


Figure 7: Hydrogeological map of the study area (source: the authors)

conglomerates. The estimated maximum thickness is about 200 m. The Neogenic sequence is locally topped by Quaternary alluvial deposits, mainly gravels, sands and poorly consolidated conglomerates.

Starting from the main recharge areas, groundwater flows towards the valley with a main SW-NE direction, being controlled by the structural setting, karst network and limestone strata dip direction. Near the foot of the valley, part of the groundwater circulating in the Cenomanian aquifer outflows into the permeable layers of the Neogenic sequence and may then uplift along the faults thereby feeding a large number of springs (Figure 7). The most productive of the springs located in the valley is the Ain Zarqa which gives origin to the main course of the Orontes River with an estimated flow rate of about $7.7 \text{ m}^3/\text{s}$ (Kozma, 2010).

The most detailed information regarding the hydrogeological structure of the study area was mainly gathered from MEW-GDHER studies carried out within the framework of the project and literature review (e.g. Kozma, 2010). Additional data have been collected in 2013 for the specific purposes of this study, including: (a) three hydrogeological cross-sections drawn up by local geology experts; and (b) schematic stratigraphic logs, static and dynamic water levels and discharge

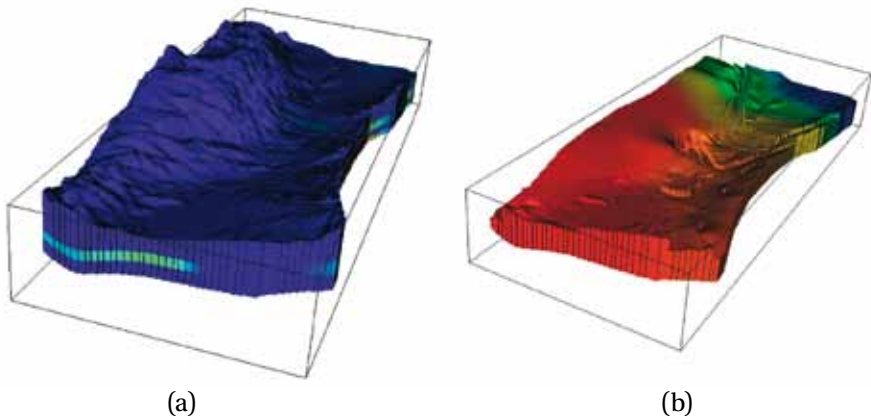


Figure 8: 3D view of the model from south. Vertical exaggeration: 5X – a) view of the entire domain with upper blue cells representing the inactive cells where unsaturated flow occurs; b) model with only the saturated or partially saturated cells

rates of 35 wells. With the help of the newly collected data, a three-dimensional hydrogeological structure of the area has been reconstructed, bearing an acceptable level of detail considering the dimensional scale of the present study. Based on the available data and information from previous studies, two different aquifer systems can be identified in the study area: (a) a Neogenic-Quaternary aquifer (multilayer aquifer with interbedding of permeable limestones and conglomerates and marl aquitards); and a Cenomanian aquifer (Cretaceous), characterized by high permeability due to fracturing and karst, and low permeability due to interbedded strata.

Based on the reconstruction of the conceptual flow model, a mathematical model of groundwater flow in the Bekaa Valley was built. MODFLOW-2000 (U.S.G.S., 2000) was chosen as the software for its possibility of being coupled to the WEAP model. MODFLOW is a numerical model that simulates the flow of groundwater in a porous medium by a finite-difference discretization algorithm. The mathematical model was built using Groundwater Vistas 6 as a graphical user interface. The program helps building MODFLOW models by providing an easy-to-use graphical user interface (GUI). The different MODFLOW files (packages) are then automatically written by the GUI and the model can be run. The model covers a total area of 65,6 km X 27 km (1770 km²) corresponding to the part of the watershed delimited by the major faults where groundwater is already collected by wells. The grid is oriented according to the main direction of the Orontes River (33 degrees East of North), in order to allow an optimal overlapping with the watershed and minimize the number of total cells. The domain is divided in 328 rows and 135 columns. Each cell has a fixed dimension of 200 X 200 meters. Five layers divide the domain along the vertical direction. Each layer is made up of 44,280 cells. The model is therefore composed of a number of 221,400 total cells (as the sum of active and inactive cells), with a total number of 174,405 active cells. Indeed, some cells lay outside of the hydrogeological basin and were therefore deactivated (set as no-flow boundary conditions). Figure 8 shows a 3D view of the model from south.

After calibration on the basis of head and flow observations, the groundwater model developed with MODFLOW allowed calculation of the mass balance computation at the end of a 12-month transient simulation set by capturing the local “water year”, being November the start of the rainy season. The total

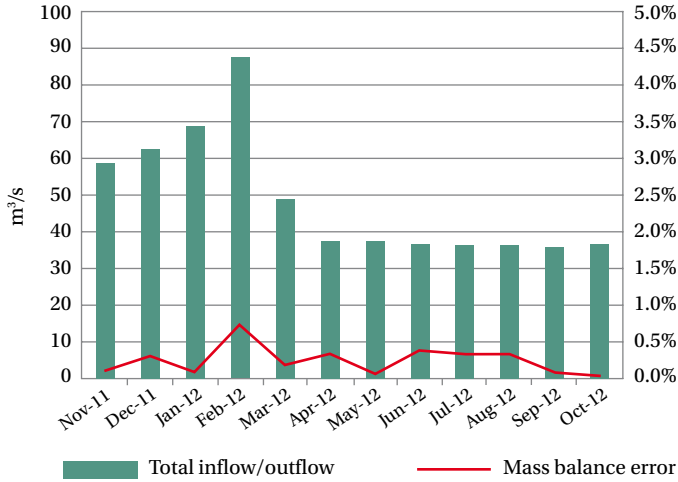


Figure 9 : 12-month transient simulation: mass balance

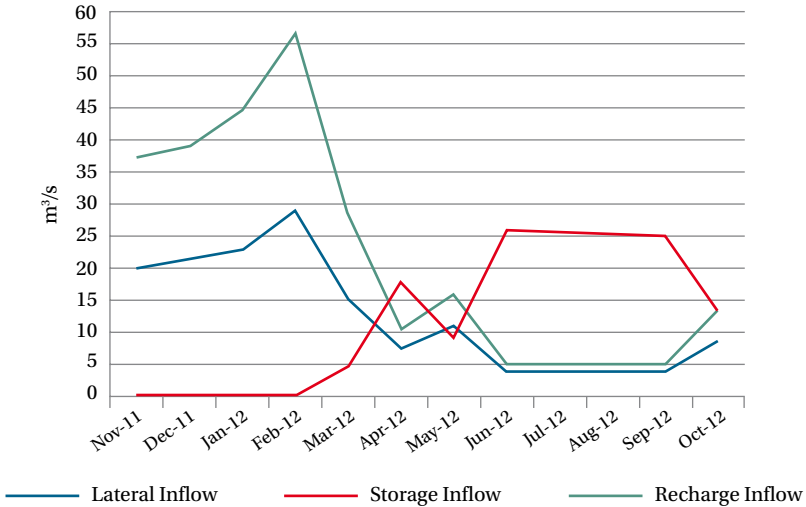


Figure 10: 12-month transient simulation: inflow

flow rate within the model domain varies roughly between $35 \text{ m}^3/\text{s}$ and $85 \text{ m}^3/\text{s}$ (Figure 9), with maximum amounts during the period from November to February, when the recharge from rainfall is higher (Figure 10). Figure 11

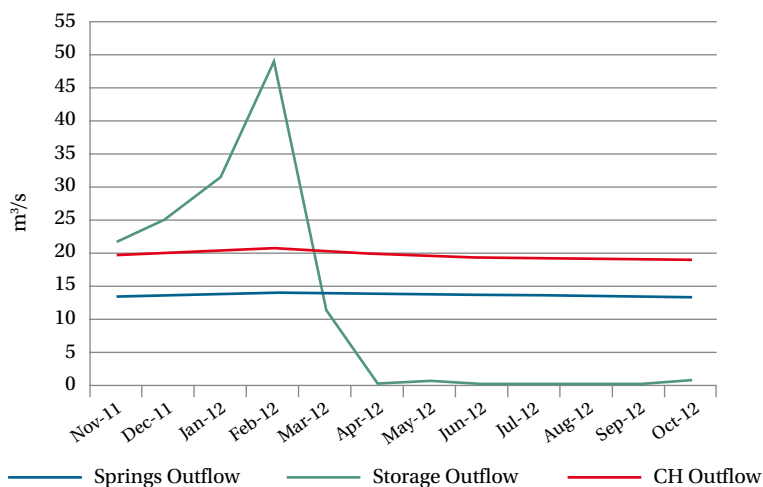


Figure 11: 12-month transient simulation: outflow

shows the outflow. The balance error is always less than 1% of the total inflow. The Orontes river flow rate appears relatively stable, with values of 13-14 m³/s, comparable to the streamflow values reported in previous studies (UN-ESCWA and BGR, 2013; Haliéus, 2008). It has to be considered that, even if the river's actual regime depends on flow regulation along the main river stem by canals and dams, it shows indeed a behavior highly dependent on meteorological variations.

2.4 Information system based on WEAP software tool for water planning and evaluation

The software WEAP⁵ (Water Evaluation and Planning) was chosen to develop an integrated software platform for improved water management. Indeed, WEAP allows modeling demand-side issues, such as water use allocation schemes, water use patterns and equipment efficiencies. These can be taken into account along with driving forces on the supply side (i.e. meteorology) to develop and assess different scenarios with the ultimate aim of designing

⁵ Usually referred to as WEAP21 (<http://www.weap21.org/>)

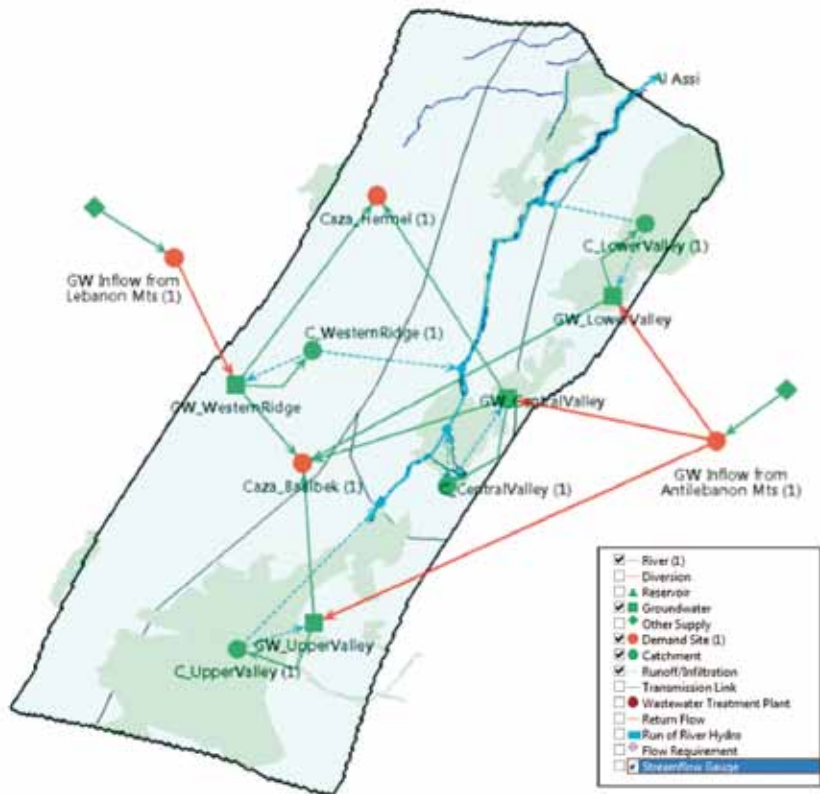


Figure 12: Scheme of the Orontes River Basin in WEAP

appropriate water management policies. Figure 12 shows the scheme of water allocation in the Orontes River Basin designed with WEAP, thanks to data on water consumption collected through the Ministry of Water and Energy as well as its partners, local scholars, and international databanks.

WEAP was linked to the groundwater model described in paragraph 2.3 and a transient simulation was run over the same 12-month period simulated in MODFLOW. The groundwater reservoir was assumed to recharge both laterally and vertically, by the inflow originating in the Lebanon and Anti-Lebanon

infiltrating along the fracture-system, and by rainfall, quantified based on the available meteorological data from the ICT project weather stations. By contrast, springs and wells have been considered as points of groundwater outflow and their discharge rates were quantified through direct survey. WEAP was also linked to MABIA – which is a software model allowing simulation of crop irrigation schemes based on crop requirements, evapotranspiration and soil water capacity. Such software component is particularly useful in the context of the Orontes River Basin, given the high agricultural potential of the basin. The WEAP-MABIA integration offers the opportunity to develop scenarios of water withdrawal for the different crops being cultivated in the basin, addressing also the economic costs and benefits of different irrigation schemes based on seasonal agricultural incentives, crop prices, and costs of water. Specifically, three different water consumption scenarios were modeled and are available in the following table. The scenarios illustrate the potential of WEAP to envision future developments or to respond to situations of water stress.

Scenario	Irrigation Trigger	Irrigation Amount	Total Irrigation Volume/year
Reference	100% of RAW	100% Depletion	136 MCM
Fixed Irrigation	Fixed interval of 7 days	100 mm	850 MCM
Stress Irrigation	100% of TAW	50% of RAW	26 MCM

Table 1: Water scenarios modeled with WEAP-MABIA (RAW: Readily Available Water; TAW: Total Available Water; MCM: Millions of Cubic Meters)

3. Final remarks and the way forward

Thanks to the simulations conducted through the Decision Support System composed by the integrated set of data and information tools described in previous paragraphs (i.e. WEAP, MABIA, MODFLOW, etc.), a series of interesting insights were obtained.

First of all, the present study confirmed the high dependence of the water of the

Orontes River Basin on local meteorological variations, beyond the obvious direct linkages between the river water regime and flow regulation along the main river stem by canals and dams. The initial hypothesis of strengthening data collection systems and introducing information tools to tackle climate change was thus confirmed by the very same dataset retrieved through the project. Furthermore, the Orontes river flow rate appeared relatively stable according to the simulations, consistent with those reported in previous studies (UN-ESCWA and BGR, 2013; Haliéus, 2008).

Nevertheless, it should be underlined that the simulations conducted in the framework of the ICT project have an inherent bias, since the datasets the model is based on lack some relevant information on the hydrogeological setting which has been integrated through expert-knowledge assumptions. For this reason, the study carried out is not meant to be an exhaustive analysis of the surveyed conditions and their likely evolution in the near future, but rather a proposal for an integrated analytical framework in support of decision-making processes.

The value of the ICT project, in fact, lies in the further development it may have in terms of creating a database able to surmount the actual model limitations and to implement an integrated decision supporting tool for water management. The project laid the foundation of the database on which to build a more integrated information system able to serve MEW-GDHER and the other stakeholders of the water sector in Lebanon, with the ultimate aim of improving the sustainability of water management at the local level. Such a tool can be fruitfully used locally and shared with the other riparian countries, namely Syria and Turkey. This may lead to possible positive outcomes in the management of international watercourses as well, such as in the case of the Orontes River Basin – which Lebanon, the Syrian Arab Republic and Turkey do share. The dynamic modeling of groundwater resources, allowing for water availability assessment throughout every season, offers also a valuable data-driven platform to establish an international dialogue about the impact of the recent political crisis in Syria on the water resources of the Orontes River Basin. In this context, the outcome of the ICT project is to be considered as a valuable basis for establishing interstate collaborations towards the sound management of common resources, hopefully overcoming past frictions.

Finally, the benefits provided by the ICT project would also extend their reach at a broader scale, since the elaboration of a geoinformation package illustrated in paragraph 2.1 will help improve data sharing with the international community through the interface of Google Earth⁸. Similarly, the outcome of the ICT project will facilitate raising awareness about water management, which in the present scenario is particularly relevant to addressing environmental challenges in the context of climate change.

References

- Asian Development Bank (2007). Asian Development Outlook: achieving water security for Asia.
- ASTER (2014). Website: <http://asterweb.jpl.nasa.gov/>
- Ceccarelli S. (2010). L'Ecosistema del fiume Assi (Libano): analisi, monitoraggio e sviluppo sostenibile. Available at: <http://utagri.enea.it/sites/default/files/seminari/libano.pdf>
- Daeron M., Klinger Y., Tapponnier P., Elias A., Jacques E. and Sursock A. (2007). 12,000-Year-Long Record of 10 to 13 Paleoeearthquakes on the Yammouneh Fault, Levant Fault System, Lebanon. *Bulletin of the Seismological Society of America* 97(3): 749-771.
- Develle A.-L., Gasse F., Vidal L., Williamson D., Demory F., Van Campo E., Ghaleb B., Thouveny N. (2011). A 250 ka sedimentary record from a small karstic lake in the Northern Levant (Yammoûneh, Lebanon). *Palaeogeography, Palaeoclimatology, Palaeoecology* 305: 10-27.
- Global Mapper (2014). Website: <http://www.bluemarblegeo.com/products/global-mapper.php>
- Gomez F., Meghraoui M., Darkal A., Sbeinati R., Darawcheh R., Tabet C., Khawlie M., Charabe M., Khair K., Barazangi M. (2001). Coseismic displacements along the Serghaya Fault: An active branch of the Dead Sea Fault System in Syria and Lebanon. *Journal of the Geological Society* 158: 405-408.
- GRASS (2014). Website: <http://grass.osgeo.org/>
- Haliéus (2008). Recupero e rafforzamento delle attività produttive generatrici di reddito a favore della popolazione di Chowaghir e Hermel nel Nord della Valle della Bekaa, Rapporto, Programma Ross L06-A1420, Libano.
- Kozma F. (2010). Hydrogeological and geological maps of the Orontes river basin, Lebanese Republic, Ministry of Energy and Water, General Directorate of Electric and Hydraulic Resources.
- Landserf (2014). Website: <http://www.landserf.org/>

- Sprague R. (1980). A Framework for the Development of Decision Support Systems. *MIS Quarterly* 4(4): 1-25.
- Tsoi A.C. (2006). Collaboration Between China and Australia: An e-Water Workshop Report. *APWeb* 3941: 967-973. Available at: http://dx.doi.org/10.1007/11610113_103
- UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe) (2013). Inventory of Shared Water Resources in Western Asia, Chapter 7: Orontes River basin.

Data analysis and policy development originating from the application of ICT tools for the Orontes Basin

BIANCA DENDENA AND STEFANO BOCCHI

1. Introduction

The Orontes River is a transboundary river flowing through three countries, namely Lebanon, Syria and Turkey. All three are situated in the Middle East region that is currently experiencing an increasing demand of water resources against a decrease in water supply, both likely exacerbating in the near future. These opposite trends are respectively mainly due to population growth and climate change, which effects will contribute to worsen the stress the water resources in the area are already subject to.

The ICT project¹, which provided the experience this document is based upon, was implemented with the aim of better understanding and managing the climatic and anthropogenic drivers currently active in Lebanon and likely affecting water resources in future years. In particular, Information and Communication Technologies (ICT) have been chosen as the tool for achieving such a goal, given their key role in supporting the management of water resources in agriculture, where different uses may result in conflicts that need to be addressed for achieving a sound management of natural resources.

¹ *New technologies (ICT) for an integrated and sustainable management of natural resources in Lebanon.*

The project focused specifically on the Orontes River in Lebanon, though just a small section of its course is located in Lebanese territory. The reason for this lies in the strategic importance of the Orontes waters in this rural area, mainly dedicated to agricultural activities strongly dependent on surface water. A responsible water management would indeed support and likely boost the local agricultural development inasmuch to approach the productivity level currently experienced beyond the Lebanese-Syrian border, both in Syria and Turkey. In fact, Syria and Turkey have dominated water resource use in the basin with various development plans to increase the irrigated surface area, which since the '80s has doubled for both countries. However, the basin's sustainability is now threatened by heavy exploitation of water resources and economic expansion. The implementation of the ICT project would therefore contribute to adopting appropriate water management practices that support the development of sound agricultural strategies in Lebanon, thus hopefully becoming an exemplary case of natural resources management in the region. In addition, the use of ICT tools would also sustain interstate cooperation in both research and practice by facilitating the exchange of data, knowledge and expertise. Water management itself would thus become a tool for mediating and strengthening international relations, which is well captured by the term hydro-diplomacy, and would assume a significant role in an area often wrecked by territorial disputes.

Last but not least, the acknowledgment of the Lebanese position in the management of water resources in the Orontes River Basin would also contribute to strengthen the role of Lebanon in the international arena, especially with regard to negotiations over the utilization of natural resources. This would be of particular relevance when applied to the management of the Hasbani watercourse, which has historically been a source of conflict between Lebanon and Israel.

2. Geographical setting of the study area

As recently reported by UN-ESCWA and BGR (2013), the total length of the Orontes River is 404 km and the corresponding watershed has been quantified in 26,530 km². Three karstic springs are officially reported for the river, namely

the Al-Labweh – which has historically been diverted towards Kaa –, the Ain Zarqa and the Daffash. These sources lie in the northern Bekaa Valley in Lebanon at an altitude of 690 m above sea level (UN-ESCWA and BGR, 2013). The Orontes River runs from south to north parallel to the coast, with two main tributaries which are also shared with Turkey and Syria: the Karasu and Afrin Rivers. The Orontes river regime displays the typical pattern of Mediterranean rivers, showing winter peak flows fed by rain and snow falls, and groundwater discharge maintaining the low summer flows. Groundwater contributes overall up to 90% of the stream flow, being mainly recharged by the snow cover in the Lebanon and Anti-Lebanon Mountains. The west and the east side of the Orontes rift valley differently contribute to the river and its tributaries, the former being characterized by precipitations ranging from 600 to 1500 mm/year and the latter by precipitations from 400 to 600 mm/year, thus feeding only ephemeral tributaries (GWP-Med, 2012).

The mean annual flow volume for the Orontes Basin, including both the Afrin and Karasu tributaries, has been estimated at about 1,200 MCM. The data recorded at Hermel in Lebanon show a mean annual flow volume of 410 MCM/year for the reference period 1931-2011, whereas the mean annual flow volume at Darkosh at the Syrian-Turkish border was 949 MCM/year between 1964 and 2011. The latter value shows a minimal but statistically significant negative trend over the reference period (UN-ESCWA and BGR, 2013). Interestingly, a mean annual flow volume of 202 MCM/year has been recorded at the Al Omeiry station close to the Lebanese-Syrian border north-east of Hermel, thus indicating a notable water withdrawal from the Orontes River in this area, likely used for irrigation purposes (UN-ESCWA and BGR, 2013).

Overall, notwithstanding the variability of the flow volume showing a seasonal pattern characterized by increased discharge during the rainy winter season and a significant decrease during the dry summer months, the Orontes river regime cannot be considered entirely natural. In fact, the whole river stem has been heavily regulated by canals and dams. This can be observed especially along the middle and the lower courses.

The Orontes basin area is differently distributed among the riparian countries, with the largest section in Syria (67%), followed by Turkey (25%) and Lebanon (8%) (UN-ESCWA and BGR, 2013).

All three riparian countries use the water resources of the Orontes River for agricultural, domestic and, to a lesser extent, industrial purposes. Syria and Turkey, in particular, have played a major role in exploiting such resources by promoting several development plans to increase their irrigated surface area. In this regard, the Food and Agriculture Organization (FAO) estimated that, in 2009, 58% of the 300,000-350,000 ha of irrigated area in the basin was situated in Syrian territory, 36% in Turkey and 6% in Lebanon, determining overall an annual water abstraction volume for agriculture of about 2,800 MCM (FAO, 2009). Such feature points at an intense withdrawal which, along with the heavy exploitation of the territory due to the population growth and economic expansion, is significantly compromising the sustainability of development in the area, especially in Syria and Turkey.

3. Agreement & cooperation over the Orontes River Basin: the Lebanese position

As stressed by UN-ESCWA and BGR (2013), there are a number of bilateral agreements on the exploitation of water resources in the Orontes River Basin, but significantly none of them involve the three riparian countries.

On the Syrian-Turkish side, formal cooperation started in 1939 when the two countries signed the “Final Protocol to Determine the Syria - Hatay Border Delimitation”: this agreement defined the equitable share of the water resources of the Orontes, Karasu and Afrin Rivers where these demarcated the border between Syria and Turkey. Since then, the relationship between the two countries over the use of the Orontes water has alternatively been characterized by high pressure, often intertwined with their disagreement on the exploitation of the Euphrates River. This friction was further enhanced in the 1980s by the aspirations of both countries regarding the contended Hatay region, which Syria claimed as its own, thus considering the Orontes as a national river not to be shared. The signature of a Free Trade Agreement in 2004 constituted the economic rapprochement between the two countries and has tightened their cooperation – as testified by the several joint projects Syria and Turkey signed between 2006 and 2010 – before being definitely compromised by the outbreak of the Syrian crisis in March 2011.

Similarly, the negotiations between Lebanon and Syria over the use of the Orontes water date back to the 1940s and have since been marked by several events. The first formal agreement was signed in 1972, but it never came into force due to political issues existing between the two countries at that time. In 1991 Lebanon and Syria established the formal basis for cooperation on the use of water from the Orontes River, as well as on other sectors, by signing the “Fraternity, Cooperation and Coordination Treaty”. In this framework the Lebanese-Syrian Joint Committee for Shared Water was set, gathering representatives from the Lebanese Ministry of Energy and Water and from the Syrian Ministry of Irrigation. In 1994 a specific agreement on the Orontes River was signed with the aim of formally acknowledging the need to share and equitably use water resources in the basin. The so-called Agreement on the “Distribution of Orontes River Water Originating in Lebanese Territory” defined for Lebanon an annual share of 80 MCM of water, provided that the river resources within Lebanese territory reached or exceeded 400 MCM/year. With regard to the withdrawal of groundwater from wells, it was agreed that the operational wells drilled before the signature of this agreement would remain in use, but it was forbidden to drill any further wells. The conditions of the agreement were deemed unfavorable to Lebanon that would have had to bear the load of drought, if any. Therefore, an annex was added in 1997 to identify four sub-basins and a main spring to be excluded from Lebanon’s 80 MCM/year share. The Agreement of 1994 was also considered as not compliant with the United Nations Convention on the Law of the Non-navigational Uses of International Watercourses (1997), in that it did not mention some essential principles of international transboundary water law, such as the obligation of exchanging information and data on the river basin and the obligation not to cause harm to any other riparian states. Hence, in 1999 a commission of experts from the Lebanese Ministry of Water and Energy was set up with the aim of revising the Lebanese situation versus the Syrian position after the Agreement of 1994 by turning it into a “win-win” solution (GWP-Med, 2012). As a result, the “Amendment to the Agreement on the Distribution of Orontes River Water Originating in Lebanese Territory”, proposed in 2001, was officially signed in 2002, thus allowing Lebanon to build infrastructures on the Orontes River. Since then, the Lebanese-Syrian cooperation efforts on the Orontes River have been strengthened and have led to the creation of a special joint committee

established under the Lebanese-Syrian Joint Committee for Shared Water in 1991. The committee is the acknowledged entity for promoting an integrated water management framework with the aim of enforcing the cooperation on issues related to shared water resources. It consists of two sub-committees, namely the River Protection and Environmental Preservation Sub-Committee and the Sub-Committee for the Expropriation of Lands in the Vicinity of the Zeita Canals. The former is responsible for coordinating and supervising issues related to river hydrology, river pollution and river infringements, whereas the latter is supposed to address issues related to lands across the Lebanese-Syrian border in the vicinity of the Zeita Dam.

The above-mentioned agreements, as well as the cooperation efforts displayed by the three riparian countries, are particularly relevant in light of the intense exploitation expected for the Orontes River, especially in the Syrian and Turkish territories, calling for integrated measures towards sustainable development. In recent years, in fact, both Lebanon and Syria have tried to involve the international community seeking support for integrated water management and hydrological monitoring, which resulted in the signing and launching of several projects. However, the Syrian crisis is hampering the important results achieved so far through hydro-diplomacy, where water is a key element for leveraging the interstate collaboration in a fragile area.

4. Orontes water management in Lebanon: state of the art and driving pressures

The Orontes River Basin offers interesting analysis perspectives in that it is subject to a varied range of either anthropogenic or human-enhanced pressures which combination will likely hinder the sustainable use of local water resources thus affecting the activities currently depending on them. The thorough understanding of such drivers is thus essential to provide the framework for implementing any research action, in turn aimed at designing and implementing strategic plans for preserving and optimizing the use of water resources. Therefore, an overview of the main drivers affecting water availability and quality is hereby provided with regard to the context being analyzed.

4.1 Agricultural activities

Agriculture is for Lebanon the most water-demanding sector, accounting for 60-70% of the water resources (FAO, 2009; ELARD, 2010). In 2005, almost 50% of the cultivated area was irrigated (MoA, 2007), but interestingly the total area equipped for irrigation has barely extended since the '80s to date, notwithstanding the increase in water consumption positively correlated to population growth and Gross Domestic Product (GDP) observed during the same reference period (Varela-Ortega et al., 2013). The water demand for agricultural purposes is further enlarged by the widespread adoption of low efficiency irrigation techniques: this is the case of gravity (or surface) irrigation, mainly from surface water, applied to 57.2% of the irrigated land (FAO, 2009). In 2000 only 7.7% of irrigated land was irrigated by drip technique (FAO, 2009). Such a technique, along with sprinkler irrigation, is commonly fed by groundwater and the two of them are mainly applied to some crops including potato, vegetables and cereals (ELARD, 2010). Overall, most of the irrigated lands draw on surface water resources (44.4%), while groundwater use accounts for 22.2% of the irrigated lands, with the remaining 33.3% of irrigation water coming from mixed surface water and groundwater sources (FAO, 2009). Agriculture water withdrawals as share of total water withdrawals have decreased from 67% in 2000 to 60% in 2005 (ELARD, 2010). This trend may be due to different factors including the relative stagnation of the Lebanese agricultural sector, the decrease of population employed in agriculture, and the decline in production. Specifically, the latter is caused by the reduction of the average allotment size due to inheritance laws, which often makes agricultural activities barely or even not profitable.

The most important crops cultivated in Lebanon include cereals, vegetables, fruit trees as well as olives, the latter considered as a standalone category due to its economic importance. These crops form the basis of the diet and thus assume particular relevance in ensuring the food security of the Lebanese population. Considering the study area, i.e. the northern Bekaa Valley, wheat is the most widely grown cereal crop. It is mostly rainfed, but supplementary irrigation can take place in April-May resulting in improved yield if rainfall is not sufficient (MoA, 2007). Currently the temperature range in Lebanon is suitable for wheat production: mild humid winters are in fact favorable to wheat, even though yields can be seriously compromised due to the lack of rainfall in spring.

Therefore, wheat yield is significantly correlated to rainfall amount, especially in April, when pressure on water availability has recently been found to be particularly relevant for most countries in the Middle East and the Northern Mediterranean region (Terink et al., 2013). This dependence on rainfall, as well as on temperature – particularly on frost –, makes wheat moderately vulnerable to the climate change effects projected for the area, as the Bekaa Valley is expected to experience reduced precipitation and more frequent frost (see paragraph 4.2).

Potato is the third most consumed crop in Lebanon after wheat and rice, but whereas tender wheat and rice for national consumption are imported, potato is locally cultivated. In light of this relevance, potato production is an indicator of national food security. Potato cultivation totally relies on irrigation, usually by sprinklers, and starch accumulation is dependent on temperature that might significantly affect quality. Taking account of these requirements, the overall vulnerability of potato to climate change effects is considered high, especially in the Bekaa region, due to reduced water availability possibly leading to lack of irrigation and temperature extremes (ELARD, 2010).

Tomato is the major fruit vegetable cultivated in Lebanon. It is cultivated as an annual crop all over the country, where the Bekaa Valley is amongst the most significant production areas. Tomato is grown either in greenhouses or in fields, mostly as an irrigated crop. Although the tomato plant is not very water demanding, water stress and long dry periods cause the fruits to crack and reduce the plant productivity. Tomato production would be slightly affected by the temperature rises projected by the 2030s (see paragraph 4.2), but yield decrease could become significant by the end of the century, when temperature rise will most severely hit the area. In these conditions, the growing period would be shorter, with less fruit set in summer due to temperature extremes, and water shortage, especially in the Bekaa region and mid-range altitudes. Therefore, the Bekaa Valley, along with the Marjayoun plains and the coastal zones are considered vulnerable for tomato production, also in light of the demographic pressure likely to be experienced in these areas leading to the relocation of greenhouses and fields (ELARD, 2010).

The economically most significant fruit trees include cherry, apple, grapevine, banana and citrus, the latter being gradually replaced by banana along the

coast. Usually orchards are irrigated. Each of the aforementioned species has specific requirements in terms of chilling hours, temperature and sensitivity to frost and dry spells and will thus differently suffer from the effects of climate change expected in the Bekaa region. Overall, the vulnerability is mainly due to the sensitivity to increase in temperature, causing the risk of chilling hours necessary for blossom not to be ensured (ELARD, 2010).

Olive tree is particularly important for the local diet as it is the main source for fat intake. Olive tree orchards are mostly non-irrigated due to the ability of the olive plant to tolerate drought being well-adapted to the Mediterranean hot and dry summer. However, in the District of Hermel, olive groves may be irrigated since precipitations (<300 mm per year) do not meet the minimum water requirement. The northern Bekaa is indeed expected to suffer the most due to climate change effects on olive cultivation, as water scarcity and extreme climatic conditions expected in the area will pose olive production at risk.

4.2 Climate change

The Middle East is expected to be the first region of the world to effectively experience increasing water scarcity (Allan, 2001). This is likely due to the combination of different driving pressures leading to a rapid increase of non-agricultural water needs. These needs will possibly be met only by further exploiting available water resources which are already under stress. In this framework, climate change is expected to be amongst the factors likely further challenging water availability in an area that is currently experiencing notable population growth and economic development.

In order to cast light on the effects of climate change on water availability in the region, different studies have recently come up, though pointing at different situations given the variety – and uncertainty – of the models being used to simulate future scenarios. Some of these studies depict Lebanon as significantly affected by the effects of climate change on water availability, whereas others deem just marginal the role of climate change against other pressures. Nevertheless, there is widespread concern on the status of water resources in Lebanon in the near future. Lebanon, in fact, used to be named the “water tower of the Middle East” due to its considerable water resources. However, in few decades it turned out to be a country under water stress (Shaban, 2011). The role of climate change in

determining this trend is still controversial in that the analysis of ground records, combined with both historical series – when available – and projections based on climate models, result in different situations. With regard to precipitations, for instance, Shaban (2011) stated that the amount of water from rainfall has not remarkably changed in Lebanon over more than forty years (1967-2009). By contrast, Lelieveld and coworkers (2012) evidenced a strong drying trend over the whole Middle East area starting in the early 1960s with lowest precipitation rates in the late 1990s. In line with these projections is the study by Chenoweth and collaborators (2011) that, while projecting an overall decrease in precipitation over the Eastern Mediterranean and Middle East region by 10%, depicts a critical framework especially for Lebanon which is expected to experience a reduction by 31% in the reference period 2070-2099 compared to 1961-1990. These modifications in the precipitation pattern in the whole region will also show a high variability in space: the Eastern Mediterranean, including Lebanon, is in fact projected to experience a drying trend, especially in winter. On the contrary, the southeastern part of the domain will be characterized by a statistically significant increase in precipitation, related to the northward expansion of moist air masses from the tropics (Lelieveld et al., 2012).

Like the amount of precipitation, also the distribution of rainfall is expected to change during the 21st century: in Lebanon, as well as in the Balkans, Turkey, Cyprus, and Israel, the number of rainy days may decrease due to a reduction of cloudiness, which allows more solar radiation to be absorbed at the surface, thus also contributing to a concomitant increase in temperature (Lelieveld et al., 2012).

Another recently studied factor corroborating the increase of water stress in Lebanon is the change in the vegetation reference evapotranspiration, which is indeed commonly referred to as a proxy of changes in water stress. Lebanon, in fact, as well as the majority of countries in the area, is expected to experience an increase in evapotranspiration both in the near and far future (up to 2050). Interestingly, when analyzing annual and monthly extremes, no significant decrease in minimum precipitation is reported, against an increase in the maximum evapotranspiration. This indicates that the temperature – on which evapotranspiration is dependent – is the most relevant climate variable, rather than precipitation (Terink et al., 2013).

Temperature has indeed been found sensitive to climate change worldwide and specifically in the Middle East area: specifically for Lebanon, in Beirut a statistically significant increase of 0.28°C per decade has been observed/simulated from 1901 to 2100 (Lelieveld et al., 2012). Whereas this warming trend is spatially uniform for winter minimum temperature as observed and derived over the period 1951-2100, the increase in the maximum temperature is expected to be more pronounced in the northern part of the Middle East region with respect to the same reference period. This indicates a continuation of the increasing intensity and duration of heat waves observed since 1960 (Lelieveld et al., 2012).

The reduction of precipitation, coupled with the increase of temperature driven evapotranspiration, is expected to cause a decrease in Lebanon's water supply. In this regard, the Lebanese internal water resources are projected to decrease from 3.7 km³ per year for the reference period 2040-2069 to 3.2 km³ per year by the end of the century. This is in line with the trend to be likely experienced by the whole Eastern Mediterranean and Middle East region (Chenoweth et al., 2011). Such a reduction will be likely due to the drying out or disappearance of springs, as well as to the decline in the amount of discharging water in rivers and streams. Such a decline, which also affects groundwater by limiting the aquifer recharge, derives from the gradual reduction of snow melting, caused by the contraction of snow cover areas correlated to temperature increase (Shaban, 2011). Though being dependent on rainfall by diffusive infiltration, groundwater is less dependent on climate variability than surface water, thus working as a reservoir during the dry season, when water demand is higher (Kundzewicz and Döll, 2009). In Lebanon, similarly to surface water, groundwater is currently under stress, notably in regions where surface water sources are few. This causes groundwater to be overexploited with negative effects on the depth of wells, in turn determining higher pumping costs and brackish water intrusion, especially in coastal zones that are affected by sea level rise (Kundzewicz and Döll, 2009).

4.3 Urban development and differentiation of water use

Population growth and economic development are considered to play a major role in the demand for water, especially in the Middle East where both factors are expected to boost in the near future. Lebanon is indeed facing a continuous

population growth, even though the rate has consistently slowed down over the last decades due to both fertility rate reduction and lifestyle changes, particularly in Beirut and the Mount Lebanon Governorate. The most recent available national projections show an annual growth rate of about 1% between 2000 and 2030, which is less than half the rate observed between 1900 and 1997. Also migration patterns from and to neighboring countries could generate consistent flows, depending on the temporary sociopolitical situations and are thus difficult to foresee. Interestingly, the North and Akkar as well as the Bekaa and Baalbeck-Hermel Governorates, where the largest agricultural areas of the country are located, will witness the highest population growth rates by 2030 (CDR, 2005). This will pose considerable challenges for the development of the agricultural sector as there will necessarily be contrasting issues to be solved. Population growth, in fact, means an increasing demand for urban land, thus conflicting with agricultural purposes. This is particularly true in the Lebanese context, where a high percentage of agricultural land is privately owned and land designations are often either weak or neglected. Moreover, the lack of urban planning and/or inadequate urban regulations is facilitating urban sprawl at the expense of agriculture devoted areas, as well as of natural landscapes (MOE/UNDP/ECODIT, 2011). The uncontrolled erosion of agricultural land into urbanized areas, pushed forward by private investors searching for rapid return, is reducing productive lands, which may pose significant risks to local food security. Specifically concerning water, the increase of population will result in higher pressure on internal renewable resources quantified in 1,136 m³ per capita in 2009. When putting together population projections with different growth rates, the internal renewable water resources currently available and the above-mentioned climate projections (i.e. reduced precipitation and higher temperature), Lebanon's water endowment results reduced to less than 1,000 m³ per capita per year for the reference period 2040-2069 (Chenoweth et al., 2011). Such a figure is noteworthy as the value of 1,000 m³ per capita per year is the threshold generally used to define water scarcity (Falkenmark, 1992). According to the worst scenario, resulting from reduced water availability in conjunction with high population growth, by 2069 Lebanon will have 630 m³ of water per capita per year, which is almost half of the water volume available in 2009 (Chenoweth et al., 2011).

Another important factor to be considered in light of the expected population growth is the differentiation of water use, particularly resulting in an increased water demand for domestic purposes. In this respect, the World Bank estimated that in 2030 water for domestic use will account for 44% of the total water withdrawal, displaying an increase of 13% with respect to 2010. The industrial use will slightly increase (from 11% to 16%), whereas water for agriculture will considerably decrease (from 58% to 40%) in line with a decreasing trend observed since 2000. Estimates from the Ministry of Energy and Water are different: according to them domestic water use will decrease from 34 to 30% with respect to 2010, and water for irrigation will increase from 54% up to 60% for the same reference period (MOE/UNDP/ECODIT, 2011).

Besides a different water use pattern, the expected population growth will exert an increasing pressure on food production and thus on land productivity, which will be likely accomplished by intensifying agricultural activities through the use of fertilizers and pesticides and, eventually, by increasing the irrigated areas. Such an intensification will likely result in significant negative externalities associated with the introduction of chemicals in the soil and water bodies, the reduction of biodiversity of animal and plant species, the erosion of natural ecosystems, as well as of the services they provide.

4.4 Human induced environmental degradation

The above-mentioned environmental issues deriving from agricultural activities are indeed present in the Lebanese section of the Orontes River, thus negatively affecting the local biological and environmental diversity.

The Orontes River Basin, as well as the whole northern territory of the Bekaa Valley, hosts a significantly high number of species with a high percentage of endemisms owing to the peculiarities of the riparian and aquatic ecosystems that have gradually evolved in the isolation due to the surrounding semi-deserted biomass. Even though Lebanon has formally acknowledged the need for protecting the biodiversity as well as the natural resources of the territory by signing the Convention on Biological Diversity (Law No. 360/94), the Orontes River Basin currently shows a high level of environmental degradation. This is mainly due to the overexploitation of local resources, the erosion of natural ecosystems and the weak application of appropriate legislation preventing these

trends. In particular, trout farming plants have been established along the Orontes. These installations have heavily modified the morphology of the river course by building concrete structures after removing the riparian vegetation. These plants have also been found to significantly worsen the water quality as evidenced by the nutrient enrichment in the water (namely phosphorous and nitrite), as well as by the bacterial load gradually increasing by moving to the lower course of the river. The analysis of the soil cover also revealed a high fragmentation of the natural ecosystems, where tree vegetation has been significantly reduced – if not removed at all – due to the extension of agricultural plots up to the stream shore with no buffer zone, thus likely causing the leaching of fertilizers and pesticides into the water body. To such degradation also contributes the construction of prospering restaurants and touristic structures on the river, as the Orontes River Basin is strategically located between the archaeological site of Baalbek and the National Park of the Haut Akkar (Haliéus, 2008).

5. Decision support for water policy development and implementation: the experience of the ICT project

As above-mentioned, the ICT project was implemented with the aim of supporting the Lebanese Ministry of Energy and Water (MEW) in managing water resources in light of the challenges that are predicted to significantly affect water availability in the Orontes River Basin.

The project was implemented on two levels, the former being aimed to introduce new technologies for data collection, analysis and sharing, and the latter focused on capacity building of both technicians and policy makers.

The project first included a preliminary assessment of the IT resources available to the MEW in order to identify the types of servers, networks, and datasets the MEW could rely on for planning water management measures. This analysis also applied to the equipment for water data collection, particularly with respect to probes for water quality assessment, discharge measurement systems and data loggers. Considering the existing gap emerged from this assessment, three additional weather stations were placed along the Orontes river course in 2010 (namely in Fekha, Jabbouleh and Younine), to collect agrometereological

parameters. Data from such stations was then paired with the data coming from the stations of the Lebanese Agricultural Research Institute (LARI) present along the river basin.

The ICT project then focused on the selection, test and implementation of an integrated decision support system for improving the management of water resources, particularly in consideration of the conflicting needs due to the different water uses in the area of implementation.

Decision Support System (DSS) is here intended as a computer-based information system supporting and facilitating decision making activities. Such a DDS system can be applied at different levels, including planning, management and operating, thus providing a useful tool for programming and delivering actions in the framework of rapidly changing conditions.

In the specific context being analyzed, the software WEAP² (Water Evaluation and Planning) was chosen as it presents features appropriate to the local conditions. WEAP is in fact a software package allowing for an integrated approach to water management. This type of approach has emerged over the last decades in light of the different driving pressures water resources are subject to, and support the design of appropriate measures for preserving both water availability and quality. In this framework, different demand-side issues, as water use allocation schemes, water use patterns and equipment efficiencies, can be taken into account and combined with climatic conditions for producing different scenarios to shape appropriate management solutions. The use of WEAP for simulating allocation patterns to different sectors is particularly suitable for the region being analyzed, where water withdrawal for agricultural, domestic, industrial and recreational purposes may result in conflicts and significantly compromise water quality.

As in the study area the withdrawal from groundwater is significant since it is the source of water for the majority of irrigated land as well as for domestic use, WEAP was integrated with MODFLOW, a numerical model that allowed for the analysis of groundwater flows and the assessment of water withdrawal from the aquifer. By using MODFLOW, the groundwater flow conceptual model initially set up was formulated as a mathematical model delimiting the Orontes

² Usually referred to as WEAP21 (<http://www.weap21.org/>).

River Basin. The study area has also been vertically discretized by using a digital elevation model basing on ASTER (a radiometer instrument onboard a NASA satellite) data. Notwithstanding the scarce availability of data for the region studied, the available information showed that the river has a draining function throughout its entire course and gathers groundwater coming from the lower layers through the fault systems.

Along with MODFLOW, WEAP was integrated with MABIA software. MABIA was used for simulating crop irrigation water requirement and schemes based on evapotranspiration and soil water capacity, thus providing an estimation of water withdrawal for agricultural purposes according to the crops cultivated in the area. Soil and crop parameters were given accordingly, whereas land use patterns and irrigation information were either derived from available data or assumed. Beyond agricultural use, also domestic and industrial driven withdrawals have been considered, including network losses. Hence, by taking into account both groundwater and surface water main affecting factors, three scenarios were set up in order to assess the effects of three different irrigation schemes on water consumption patterns, crop yield and financial impacts on farmers. The preliminary results pointed to three significantly different outcomes in terms of amount of water withdrawal for agricultural purposes and highlighted environmental issues possibly arising. However, due to the restricted dataset available for feeding the models, it was not possible to derive context specific recommendations for advising proper measures.

The limited availability of data has been the major constraint of the study, significantly affecting the range of considerations and recommendations that could be drawn from the results obtained. An extension of the project should therefore aim to install additional weather stations in order to extend the area covered by data collection, especially with respect to the mountainous areas of the Lebanon and Anti-Lebanon, as snow cover observations would positively contribute to simulate groundwater flow. Moreover, longer time series climate related data would better describe the climate trend in the area, thus allowing for predictive analysis simulating the effects of climate change on water availability. Reliable data on per-capita water demand for both domestic and industrial purposes would also help in depicting a complete framework in order to assess total water consumption and shape water allocation policies accordingly.

6. Lessons learned and the way forward

The above-mentioned studies, though reporting different data and features on the effect of climate change on precipitation, temperature and other climate variables, agree on attributing the decrease in available water resources per capita observed in Lebanon to both population growth and climate change (Chenoweth et al., 2011; Shaban, 2011), identified as the two major driving pressures. Notwithstanding the value of such conclusions in depicting and quantifying trends on global and regional scale, it is noteworthy to highlight that they are based on simulations using a varied range of models and methodologies, each built on different datasets often showing considerable gaps in terms of historical series. As a result, they provide outcomes characterized by a high degree of uncertainty.

Despite the uncertainty of the projected scenarios, the recently emerged results on the effects of climate change on the Middle East region (Chenoweth et al., 2011; Shaban, 2011; Lelieveld et al., 2012; Terink et al., 2013; Varela-Ortega et al., 2013) are important as they indicate trends and the order of magnitude of the expected changes. These preliminary data, in fact, allow policy makers to design appropriate sectoral policies for mitigating and adapting to the predictions.

According to comparative studies taking into account the Middle East region as a whole, Lebanon is endowed with significantly more per capita water resources than its neighbors, namely Jordan, Israel, Syria. However, the decrease expected will create some water supply challenges, particularly during drought years, that should necessarily be coped with. In order to overcome this concern it is necessary to take action in advance by promoting adaptation³ measures, in turn aimed at enhancing the resilience⁴ of the territory under study including population, production systems and policies in place.

³ Adaptation: the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (UNISDR, 2009).

⁴ Resilience: the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNISDR, 2009).

In the context being analyzed, agriculture has a major role in exerting pressure on water resources, therefore a key adaptation action is to set and implement a sustainable agriculture policy that shapes agricultural production systems in light of the changes being expected. Adaptation measures vary horizontally according to the agricultural sub-sectors and their vulnerability to population growth and climate change. These measures also vary vertically, according to the different actors involved in the development and implementation of the policy. While planning such measures, it should be borne in mind that data concerning the vulnerability and impact of climate change on the yields of the above-mentioned crops under Mediterranean climatic conditions remains scarce if not absent. The existing references come mostly from developed countries with similar climatic conditions (i.e. California and Southwestern Australia), and to a lesser extent from Europe, thus being hardly applicable to Lebanon. However, considering the key crops of the Lebanese agricultural sector, it is possible to draw some broad recommendations to be applied at the farm level with the aim of optimizing water utilization by reducing water consumption:

- Rainfed cereals (e.g. wheat):
 - change planting dates according to precipitation and temperature variations in order to avoid dry spells;
 - shift to less water consuming crops, e.g. barley instead of wheat, as barley is more tolerant to heat and water stress, and/or to drought- and heat-tolerant wheat cultivars with shorter cycle;
 - change the cropping pattern according to precipitation isohyets: specifically for the northern Bekaa, wheat and barley cultivation devoted area should be assigned according to the expected annual precipitation and the minimum crop requirement, 400 mm/year and 250 mm/year respectively.
- Horticultural irrigated crops (e.g. potato and tomato):
 - change planting dates, according to temperature variation coupled with lower frost risk and lower soil moisture;
 - shift to less water consuming crops or cultivars, and replant the same perennial crops or varieties on drought tolerant rootstocks (especially for cucurbitaceous and solanaceous varieties) in order to reduce water demand for irrigation;
 - shift to more heat tolerant cultivars for vulnerable crops;

➤ Perennial crops (e.g. fruit trees):

- substitute, through replanting or grafting, varieties having high chilling requirements by others requiring low chilling in vulnerable areas likely subjected to increase in temperature;
- Replace water-consuming crops with less water consuming crops as well as with crops/cultivars better tolerating salinity.

Moreover, there are few general recommendations that are highly important to improve the efficiency of the whole agricultural system with respect to the use of water:

- take into consideration the concept of introducing new drought and heat tolerant crops in the northern Bekaa area, e.g. industrial hemp, after evaluating market opportunities for derived products;
- adopt sustainable agricultural practices such as conservation agriculture, organic farming, suitable crop rotations, etc.;
- gradually replace surface irrigation with more efficient irrigation systems as drip irrigation or sprinklers – already in use for some crops –, and adjust irrigation schedules and water quantities according to the increasing crop water demand, especially during the most critical periods as spring and summer.

Along with these measures to be taken at the field level, there are actions to be taken at a higher level, defining the framework where a sound and appropriate strategy for the agricultural sector could be designed and implemented.

In this context, first of all the legislative framework related to agriculture and natural resources management – including water – should be reviewed and harmonized with the conventions that are ratified by the Government in relation to climate change. As a consequence, national action plans should be set and implemented on the basis of a participatory approach with local stakeholders. In this respect, it is important to stress that farmers groups should be considered both as the end beneficiaries and the implementing actors of any agricultural policy, and their groups should thus be adequately supported and strengthened. Moreover, both the supported groups and the policies defined should be market chain oriented, in order to better reflect different production systems in use, as

well as their combination for designing and implementing tailored adaptation measures.

Amongst the priorities Lebanese institutions should be concerned with, the support to research institutes and academia is particularly relevant. These entities should in fact be strengthened to elaborate and implement research programs in fields related to agricultural sciences and climate change, with the aim of providing research findings supporting evidence-based policies. The existing governmental research institutions – as the above-mentioned LARI – should join venture with both local universities and regional institutions with longstanding experience in arid and semi-arid areas (e.g. ICARDA - International Center for Agricultural Research in the Dry Areas). Central to such a collaboration based on research is also the interstate cooperation amongst Mediterranean countries, particularly those experiencing the same challenges in light of climate change (Syria, Jordan, Israel, Turkey). Such a cooperation would be particularly valuable in the fragile Middle East region and should also be further extended aiming at creating a network of international research institutions that may contribute to take aimed actions in critical areas.

Specifically, in light of the preliminary results of the ICT project, research topics to be explored towards sustainable agriculture are:

- water consumption pattern and water requirements of crops and cultivars, and their variability in relation to climate change, agricultural production systems and regions;
- water treatment, water recycling, rain water harvesting (RWH) techniques at farm and regional level;
- further development of models simulating water allocation to different sectors in light of the expected population growth and climate change;
- socio-economic models promoting water price efficiency according to the cultivated irrigated crops (i.e. virtual water price);
- application of biotechnology for reducing crop water requirement;
- development of models assessing the impact of climate change on crop yield, food security, nutrition diversity, diet and food safety;
- cost assessment of adaptation measures for specific vulnerable agricultural sub-sectors.

Closely related to research is education intended as the dissemination of the

latest findings at different levels. In light of the aforementioned inter-academia collaboration, research results and technology advances from other countries should be shared in the curricula of the local universities specialized in agriculture, economics, environment and natural resources management. Research findings should also be properly disseminated to the concerned public institutions, as well as to the private sector. Similarly, awareness campaigns on water management and climate change should be implemented and capacity building should be delivered by providing assistance through adequate extension services to several target groups, including farmers' cooperatives and associations, agro-industrial producers, non-governmental organization officers, community based organizations, municipalities, water associations and water offices.

Synopsis of results and recommendations in the framework of the ICT project

Results		
Means	Preliminary results	Way forward
<ul style="list-style-type: none"> Local IT resources identified and mapped Research bodies/institutions having data on water resources identified, mapped and connected 3 additional weather stations placed in Fekha, Jabbouleh and Younine Decision support system built upon the integration of different dedicated software, namely WEAP, MODFLOW and MABIA 	<ul style="list-style-type: none"> Climate related dataset under construction through the harmonization of newly placed weather stations with those already being operated by the Lebanese Agriculture Research Institute (LARI) Groundwater flow analyzed by setting and calibrating both a steady-state model and a transient model linked to WEAP resulting in the definition of a mass balance Different irrigation scenarios simulated by WEAP upon the integration of MABIA and MODFLOW resulting in a preliminary assessment of water consumption pattern, crop yields and financial impacts on farmers 	<ul style="list-style-type: none"> Increase of weather stations in the Orontes River Basin to extend the area covered by data collection, especially with respect to the mountainous areas of the Lebanon and Anti-Lebanon Build longer time series for weather related data in order to better describe climate trend in the area and simulate the effect of climate change on local water availability Retrieve all available reliable data on per-capita water demand for both domestic and industrial purposes for assessing total water consumption
Recommendations		
Farm level	Policy level	
<ul style="list-style-type: none"> Shift to less water consuming crops (e.g. barley instead of wheat), and/or to drought and heat-tolerant crop cultivars Change cropping patterns according to precipitation isohyets Change planting dates according to precipitation and temperature variations in order to avoid dry spells Adopt sustainable agricultural practices for optimizing water retention in soil Improve the efficiency of water irrigation systems by replacing surface irrigation with more efficient methods, and adjust irrigation schedules and water amount according to the increasing water demand 	<ul style="list-style-type: none"> Review the legislative framework for agriculture and natural resources management to be harmonized with the conventions ratified by the Government on climate change Set and implement agriculture specific policies by enlarging stakeholders' participation, with particular attention to farmers' groups Support and promote research programs focused on: crop water requirement variability in light of climate change, water treatment and recycling, development of models simulating water allocation to different uses, biotechnology for reducing crop water requirement Foster the interstate collaboration on research and practice amongst Mediterranean countries with the aim of providing and sharing research findings supporting evidence-based policies 	

References

- Allan J.A. (2001). *The Middle East Water Question: Hydropolitics and the Global Economy*, London, I.B. Tauris, 387 pp.
- CDR (2005). *National Physical Master Plan of the Lebanese Territory: Uncontested Physical Features*, Beirut, Council for Development and Reconstruction.
- Chenoweth J., Hadjinicolaou P., Bruggeman A., Lelieveld J., Levin Z., Lange M.A., Xoplaki E. and Hadjikakou M. (2011). Impact of climate change on the water resources of the eastern Mediterranean and Middle East region: Modeled 21st century changes and implications. *Water Resources Research* 47(6).
- ELARD (Earth Link and Advanced Resources Development) (2010). Vulnerability, adaptation and mitigation chapters of Lebanon's second national communication – Climate risks, vulnerability and adaptation assessment (Final Report), Ministry of the Environment/United Nations Development Programme.
- Falkenmark M. (1992). Water scarcity and population growth: A spiraling risk. *Ecodecision* 6: 21-23.
- FAO (Food and Agriculture Organization of the United Nations) (2009). Lebanon - Irrigation in the Middle East region in figures - Aquastat Survey 2008. Available at: http://www.fao.org/nr/water/aquastat/countries_regions/LBN/LBN-CP_eng.pdf
- GWP-Med (Global Water Partnership - Mediterranean) (2012). Framework study for international water basin management in Lebanon - 2nd progress report.
- Haliéus - Organizzazione di cooperazione Internazionale per la pesca, l'acquacoltura, la ricerca, lo sviluppo e l'ambiente (2008). Recupero e rafforzamento delle attività produttive generatrici di reddito a favore della popolazione di Chowaghir e Hermel nel Nord della Valle della Bekaa - Programma Ross L06-A1420, Libano.
- Kundzewicz Z. W. and Döll P. (2009). Will groundwater ease freshwater stress under climate change? *Hydrological Sciences Journal* 54(4): 665-675.
- Lelieveld J., Hadjinicolaou P., Kostopoulou E., Chenoweth J., El Maayar M., Giannakopoulos C., Hannides C., Lange M.A., Tanarhte M., Tyrllis E. and Xoplaki E. (2012). Climate change and impacts in the Eastern Mediterranean and the Middle East. *Climatic Change* 114(3-4): 667-687.
- MoA (Ministry of Agriculture) (2007). Project of Agriculture Census 2005.
- MoEW (Ministry of Energy and Water) (2010). National Water Sector Strategy: Supply/Demand Forecasts, DRAFT.
- MOE/UNDP/ECODIT (Ministry of the Environment/United Nations Development Programme/ECODIT) (2011). State and Trends of the Lebanese Environment 2011. Available at: http://www.undp.org/content/dam/lebanon/docs/Energy%20and%20Environment/Publications/SOER_en.pdf

- Shaban A. (2011). Analyzing climatic and hydrologic trends in Lebanon. *Journal of Environmental Sciences and Engineering* 5: 483-492.
- Terink W., Immerzeel W. and Droogers P. (2013). Climate change projections of precipitation and reference evapotranspiration for the Middle East and Northern Africa until 2050. *International Journal of Climatology* 33(14): 3055-3072.
- UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe) (2013). Inventory of Shared Water Resources in Western Asia, Chapter 7: Orontes River basin.
- UNISDR (United Nations/Inter-Agency Secretariat of the International Strategy for Disaster Reduction) (2009). UNISDR terminology on disaster risk reduction, Geneva, United Nations Publications.
- Varela-Ortega C., Esteve P, Blanco I., Carmona G., Ruiz J. and Rabah T. (2013). Assessment of Socio-Economic and Climate Change Effects on Water Resources and Agriculture in Southern and Eastern Mediterranean countries. *MEDPRO Technical Papers* 21(3).
- World Bank (2009). World Bank, Water Sector: Public Expenditure Report, Draft 2009: 27.

Decision support for improvement of the management and cooperation for the Orontes River

GEORGES COMAIR, DAVID MAIDMENT AND DAENE MCKINNEY

1. Introduction

The Orontes is a 448 km long river shared between Syria, Lebanon and Turkey and it has a drainage area of 24,745 km². These values as well as the catchment areas for each riparian country were determined using Geographic Information System (GIS) and a newly available 30x30 m Digital Elevation Model (DEM), released in October 2011 under the Advanced Spaceborn Thermal Emission and Reflection Radiometer (ASTER) program (NASA, 2011a).

This chapter complements the analysis performed in Part II, Chapter 1 and aims at assessing the water security risks associated with the negotiations and asymmetrical power relations between Turkey, Syria and Lebanon especially under the current political events in Syria. The chapter illustrates the main findings of the UN-Watercourse Convention workshop at the University of Dundee in Scotland, in June 2012. Risk analysis was evaluated by proposing a method to allocate the water of the Orontes and optimizing the water allocations in the basin using the nine factors related to the 1997 UN Convention. This risk assessment comprises optimizing water allocation as percentage of the available resource, using factors relevant to equitable and reasonable utilization mentioned in article 6 of the UN Convention. A Geographic Information System (GIS) database, containing hydrographic data and used in the calculation of water allocations, is described.

2. Geodatabase

The geodatabase built in this study contains geographic data, including basin areas, stream lengths, and infrastructures such as dams, climatic stations and streamflow gages. The GIS tools, Arc Map and Arc Hydro (Maidment, 2002) were used to delineate the Orontes River watershed and subwatersheds from the DEM in GeoTIFF format with geographic latitude/longitude coordinates and a 1 arc-second (30m) grid of elevation postings. The Arc GIS Geoprocessing toolbox and Arc Hydro techniques were used to isolate the watershed. The outlet of the basin is situated in the province of Hatay in Turkey at 36°03'43N and 35°57'47E. The data collected for the Orontes River is part of the database developed for the Jordan River (Comair et al., 2012).

Currently, the priority of the Ministry of Energy and Water in Lebanon is to implement a Lebanese Hydrologic Information System (LHIS) for transboundary basins. This process has started using ArcGIS and the Observations Data Model (ODM) framework. The LHIS is a GIS-based, model-oriented HIS and is presented as a system that integrates GIS data models, GIS processing techniques and hydrologic models.

The development of a dynamic hydrologic system for data handling, watershed modeling and water resources assessment in Lebanon is the main aim of the proposed LHIS. The central hypothesis of the LHIS is that advancements in hydrologic modeling and the sound understating of water resources depend on the amalgamation of reliable hydrologic models with spatial and long-term time series records. This hypothesis is formulated on the basis of existing literature in the fields of hydrologic models, GIS for water resources, and the integration of data models and simulation models in water resources, more specifically the integration of watershed hydrologic models, GIS data models, and GIS processing tools in a single system framework (Maidment, 2002).

The rationale for undertaking the LHIS is that, once a complete hydrologic data model is implemented at the watershed scale, and the connection between the data model and simulation models (i.e. hydrologic models) is established, it is possible to enhance hydrologic and water resources analysis while reducing time spent on basic data harvesting and model calibration. The originality of the LHIS lies in its attempt to implement the concept of watershed modeling

using a HIS framework (Maidment, 2004; Goodall and Maidment, 2005; Maidment, 2005). Creating the LHIS involved the development of a hydrologic data management system, under ArcHydro (Maidment, 2002), for the first time in Lebanon. It makes use of the advanced capabilities of GIS to develop models that support data integration for the hydrologic simulation models. The concept of the LHIS allows running hydrologic models in an efficient and flexible manner and automates the processes for the management, communication and exchange of information between the different LHIS components. The development of the LHIS ensures data sharing, allowing for future update of the hydrologic model, and steady analysis of water resources. These outcomes positively add to the existing knowledge and contribute to the development of water resources plans and decisions making. Figure 1 shows the LHIS framework.

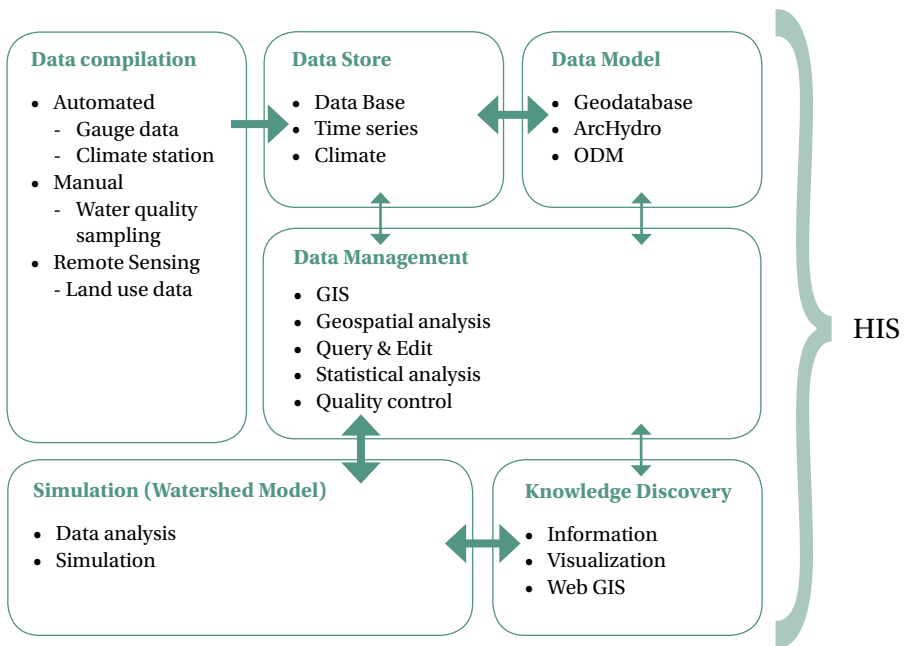


Figure 1: Prototype of the proposed hydrological information system HIS (adapted from: Maidment, 2005)

The geodatabase under the Data Model component focuses on defining the watershed physical environment using spatial and temporal data. This includes: (1) climate (precipitation, temperature and humidity); (2) hydrology; (3) water bodies (river and lakes); (4) physiographic features such as topography, soil maps, land use, geology and hydrogeology; (5) water resources data; and (6) social and economic data.

The CUAHSI (Consortium of Universities for the Advancement of Hydrologic Science, Inc.) ODM was used in the Orontes Basins (Horsburgh et al., 2008; Tarboton et al., 2011; CUAHSI, 2013). This framework provides an efficient platform to store, query and share hydrologic time series data across multiple investigators and stakeholders. Point observations such as precipitation and stream discharge have two primary attributes, location and time, and the ODM provides an optimal framework to store both of these attributes of these variables. The ODM schema classifies the attributes of the observations into facts and descriptive dimensional attributes that give the facts a context. The general format for data input to the ODM is a single file containing a table of which the headers have the same name as the columns in the ODM tables. Rules regarding input file creation, and the required and optional columns for each table to be loaded can be found in the software manual (CUAHSI, 2013).

3. Optimization and risk assessment

A mathematical optimization method: Orontes Water Allocation Optimization (OWAO) method was developed to allocate water from the Orontes River among Lebanon, Syria and Turkey. This optimization is based on the factors relevant to equitable and reasonable utilization mentioned in article 6 of the UN Convention:

The objective function that is optimized to determine water allocations in percentage is shown below:

$$\text{Minimize} \quad \sum_{i=1}^n W_i \times \sum_{j=1}^3 (X_{ij} - A_j)^2 \quad (1)$$

The objective is to minimize the sum of squared deviations between the allocation outcome A_j and the factors $i = 1$ to n .

i refers to the nine factors considered for the Orontes Basin based on the UN Convention and the Helsinki rules. These factors are:

1. Geography
2. Hydrology
3. Climate
4. Existing utilization of the waters
5. Economic and social needs
6. Population dependent on the watercourse in each watercourse state
7. Comparative costs of alternative means of satisfying the economic and social needs of each basin state
8. Availability of other water resources
9. Degree to which the needs of a basin state may be satisfied, without causing appreciable harm and substantial injury to a co-basin state

$j = 1, 2$ and 3 since we have three countries using the water of the river: Lebanon, Syria and Turkey.

W_i (%) is the weight given to each factor as mentioned in article 6, part 3 of the 1997 UN Convention. This weight was determined by its importance in comparison with other relevant factors.

X_{ij} is the share of the i^{th} factor for the j^{th} country (%). This means that for each country, X will be the share of the country according to each of the 9 factors; for example, if Lebanon is country number 1, Syria number 2 and Turkey number 3, for Lebanon's geography it will be X_{11} , for Syria X_{12} and for Turkey X_{13} .

A_j is the proportion of the total water that each country should receive (%).

Factor 1, 2 and 3 were computed using the GIS database. It is thought that any further negotiations on the Orontes River will involve mapping and data processing, making GIS a useful tool in evaluating water allocations and policy alternative.

The computation of each of the 9 factors used in the objective function is explained below:

Criteria	Countries
Most populous	Syria
Flow contribution	Turkey
Greatest current use	Syria
Poorest	Syria
Wealthiest	Turkey

Table 1: Representation of each country with respect to each criterion (source the authors)

3.1 Geography

Once the basin was delineated and the streams defined, it was overlaid with the countries shapefiles and each country within the basin was identified. Each country's subwatershed was determined using the intersect tool. This enabled catchment area calculations on GIS. Identifying the basin watershed areas will help establish the total potential run-off from each riparian country after determining the amount of precipitation and precipitation minus evapotranspiration (P-ET).

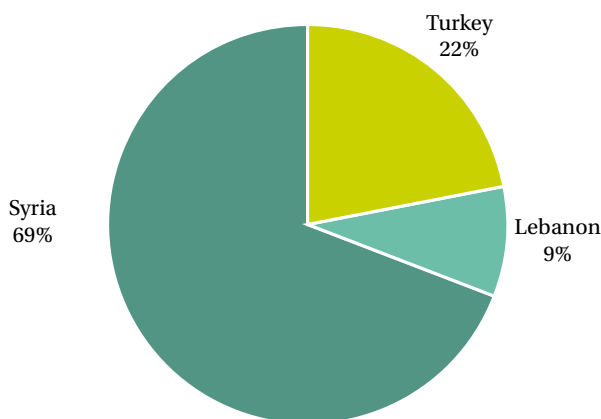


Figure 2: Catchment area percentage for each country © Georges Comair

3.2 Climate: P-ET

Using zonal statistics for each catchment area, the available water in each country was computed in MCM by multiplying the area of the watersheds by (P-ET).

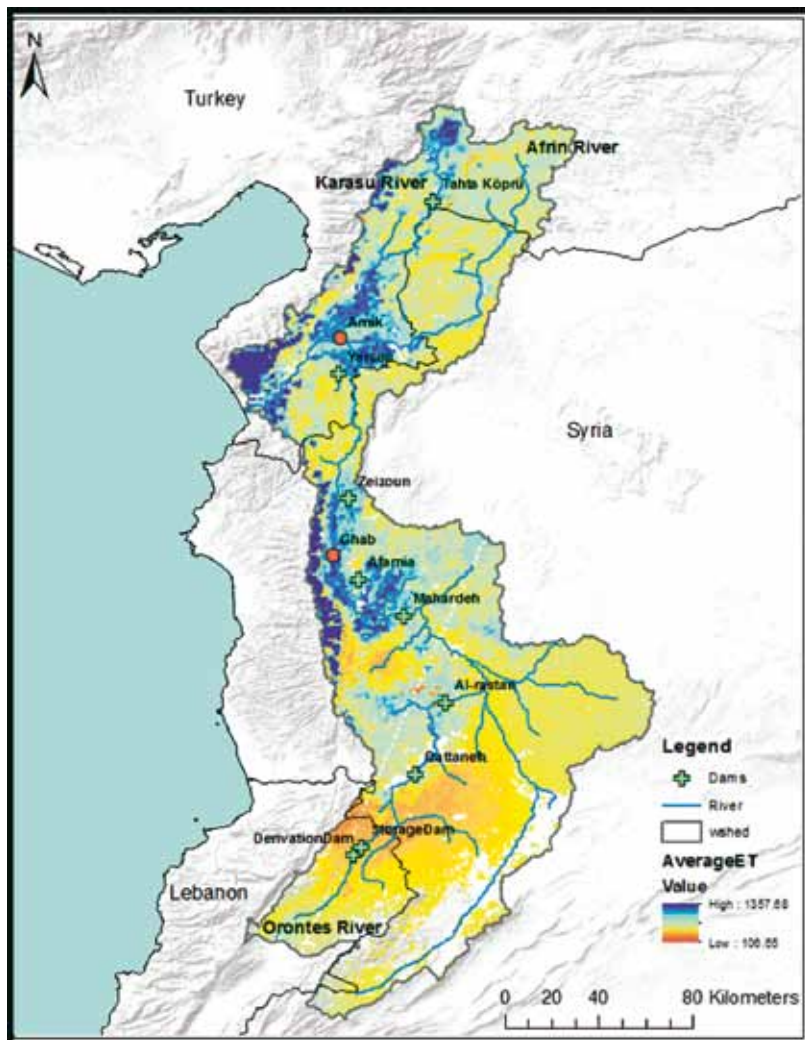


Figure 3: ET distribution over the Orontes Basin © Georges Comair

An analysis of Precipitation – Evapotranspiration was performed using GIS techniques. P-ET was used in the optimization as part of the climate factor addressed in the 1997 UN Convention. To our knowledge, this is the first attempt of studying P-ET over the entire Orontes River Basin. A similar successful approach was used by Comair et al. (2012) over the entire Jordan River Basin.

A precipitation raster was obtained from the Water Systems Analysis Group (WSAG), University of New Hampshire (Fekete et al., 2004) and incorporated into the previously mentioned geodatabase. The data was downloaded from an online GIS database in raster format. The raster represents long term (1950-2000) average annual precipitation for the globe (mm/year) on a 0.5 x 0.5 degree global grid (Comair et al., 2012).

ET was calculated using the MOD16 data product, a global map of ET derived from MODIS imagery (NASA, 2011b). It provides 8-day estimates of global evapotranspiration going back to January 2000, when MODIS was first launched aboard the NASA satellite Terra. Using these tools, all 10 years of MOD16 data were imported into Arc Map. The raster calculator tool was used to obtain average annual ET.

In order to clarify the calculations of P-ET, Table 2 shows the different factors related to the calculation of available water:

Riparian country	Evapotranspiration		Precipitation (MCM)	Available Water (MCM)	Contribution to Available Water
	(mm/yr)	(MCM)			
Turkey	312.8	1,737.8	3,678.4	1,940.6	32%
Syria	260.4	4,422.1	7,861.4	3,439.2	56%
Lebanon	221	488.2	1,236.9	748.7	12%

Table 2: Estimation of the available water based on remote sensing data (source: the authors)

Contribution to annual discharge

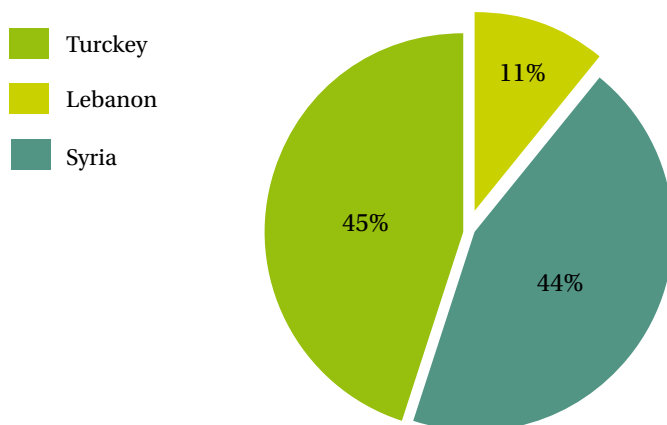


Figure 4: Percentage contribution to annual discharge © Georges Comair

3.3 Existing utilization

Lebanon is not using significant amounts of surface water from the basin. The existing utilization of the Orontes Basin waters by Turkey was estimated using values obtained from the 2008 Aquastat Survey (FAO, 2008). According to the DSI and the General Directorate of Rural Services (GDRS) that study major hydrological basins in Turkey, the Orontes Basin includes about 34,947 ha of Turkish irrigated lands (DSI, 2002). Assuming that the average amount of water needed to irrigate a hectare of land is 10,000 m³/year, the Turkish Utilization (TU) from agriculture was computed as:

$$TU = \text{Area} \times \text{water requirement per hectare} = 34,947 \text{ ha} \times 10,000 \frac{\text{m}^3}{\text{ha}} = 349.47 \text{ million m}^3$$

The Syrian water utilization was assessed making use of the FAO 2003 database (FAO, 2003). It is estimated that Syria is using about 2730 million m³ of water from the basin.

3.4 Economic and social need

The economic and social need for each country is a difficult parameter to account for because it can be very subjective. In this case, these factors were estimated based on the Human Development Index (HDI) as it takes account of both economic and social factors including: life expectancy, knowledge and standard of living. These values were obtained from the United Nations 2011 Human Development Report (UN, 2011). As the highest possible value of HDI is 1, the HDI of each country was subtracted from 1. These values reflect the progress to be made by each country to reach maximum development.

Countries	HDI	1-HDI
Lebanon	0.739	0.261
Syria	0.632	0.368
Turkey	0.699	0.301

Table 3: Economic and social needs criteria (source: the authors)

3.4.1 Population dependent on the waters

For Syria, the data for population dependent on waters in the basin was obtained from the FAO 2003 report. Turkey's population dependent on the waters was considered to be equal to the population existing in the Province of Hatay (TSI, 2010), since no relevant information was found. The population within the Orontes Basin in Lebanon does not depend on surface water from the Orontes, but uses groundwater instead. Most of the wells are not pumping from the groundwater feeding the Orontes, thus the population is not directly dependent on the waters.

3.4.2 Comparative costs of alternative means

The comparative costs of alternative means of satisfying the economic and social needs of each basin state were calculated based on the GDP of each country. The GDP values were drawn from the World Bank's database (World Bank, 2011).

3.4.3 Availability of other water resources

The availability of other water resources was calculated using the Water Stress Index (WSI). The water stress index is defined by the ratio of water demand to renewable water resources. The values of the total renewable water resources available in each country were obtained from the ESCWA report, for Syria and Lebanon (ESCWA, 2005), and from the CIA, for Turkey (CIA, 2012). The water demand values for each country were obtained from the FAO 2003 report for Syria, from the Lebanese government for Lebanon and from the Blue Peace report for Turkey (SFG, 2011).

3.4.4 Appreciable harm

The degree to which the needs of a basin state may be satisfied, without causing appreciable harm and substantial injury to a co-basin state can be related to water quality and quantity. If upstream countries such as Syria and Lebanon start polluting the river, they will cause harm to Turkey by deteriorating the water quality. In addition, too much water (i.e. inundations) can be an issue. One example of the negative effects of too much water was the Zeizoun dam break in June 2002 which inundated lands in Turkey. Due to the difficulty of obtaining water quality data, appreciable harm was quantified as the amount of water a country can control within its borders. In theory, the riparian countries can limit the amount of water flowing to the downstream countries.

Border	Mean Annual flow (BCM)
Turkey - Syria (Afrin River)	0.6
Lebanon - Syria	0.4
Syria - Turkey	1.2
Total	2.2

Table 4: Mean annual flow measured at the borders (adapted from: Kibaroglu et al., 2011)

3.5 Optimization results

Since the OWAO method uses indices pertaining to water security risks, such as HDI, WSI, significant harm and population density, it can be considered as a useful tool for evaluating water allocation in a transboundary setting.

X_{ij} which is the share of the nine factors for each country is calculated using this equation:

$$X_{ij} = \frac{F_{vj}}{\sum_{j=1}^3 F_{vj}} \times 100 \quad (2)$$

F_{vj} represents the values of each factor obtained, for example if P - ET is calculated for each country, $F_{vj} = (P-ET)A_j$

Results F_{vj} (absolute values) and its proportion X_{ij} (%) are summarized in Table 5; note that factor 1, 2 and 3 results can be seen in Tables 2, 3 and 4.

Factors	Lebanon	Turkey	Syria	Lebanon	Turkey	Syria
4 (MCM)	0	349	2730	0%	11%	89%
5	0.261	0.301	0.368	28%	32%	40%
6 (M)	0	1480571	2528000	0%	37%	63%
7 (M\$)	39006	734364	591470	5%	88%	7%
8	0.527	0.411	1.118	26%	20%	54%
9 (BCM)	0.4	0.6	1.2	54%	28%	18%

Table 5: Summary of the results obtained for each factor (source: the authors)

The derivative of Equation 1 with respect to A_j was set equal to zero and these equations were solved in order to determine the optimal allocations. The optimal allocations were obtained using the equation 3.

$$A_j = \frac{\sum_{i=1}^9 W_i X_{ij}}{\sum_{i=1}^9 W_i} \quad (3)$$

The existence of solutions can be verified using the Weierstrass Theorem which states that if a constraint set S is compact (closed and bounded) and the objective function is continuous on the constraint set than there exists an $x \in S$ such that $f(x) \leq f(y)$ for all y in S . Since we are minimizing a sum of convex functions, thus a global minimum will be obtained from the solution. The calculation of W_i (%) which is the weight given to each factor is subjective. As mentioned in Article 6 of the UN Convention: “The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors”. A weight was assigned to each factor using results obtained from two sources: (1) a class survey conducted in the *transboundary waters* class at the University of Texas at Austin and (2) a survey conducted by Mimi and Sawalhi (2003) among water experts. Therefore, the result of this optimization is one example among several possibilities of water allocations. The students gave more weights to socio-economic factors, whereas the water experts assigned more weights to hydrological factors.



Figure 5: Weights assigned to each factor © Georges Comair

The results are summarized in the figure below:

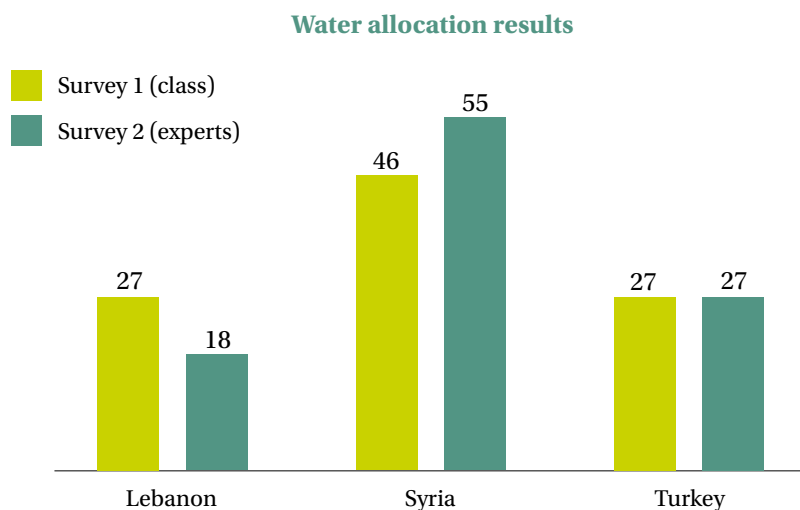


Figure 6: Water allocations results in % © Georges Comair

4. Risk assessment: how severe are the water security challenges in the Orontes Basin?

According to the Basins at Risk project (BAR) at Oregon State University, the Orontes Basin is considered a category two region where indicators and protests over water exist. Category one are areas where current conflicts exist (such as the Jordan River Basin). Given the current situation in Syria, we believe that the status of the Orontes Basin can soon be shifted to a category one region, implying a higher risk for conflicts. This is currently seen at the Syrian-Lebanese and Syrian-Turkish borders where daily clashes are occurring in Lebanese and Turkish villages surrounding the Orontes River (Ghab, Kaa, Hatay province, etc). The conflict in the Orontes Basin today is not “waterborne”, but any conflict (political, military, etc.) can make cooperation over water more difficult if not impossible.

Indicators of potential conflicts in transboundary rivers can be applied to the Orontes Basin, such as extreme changes in physical or institutional settings

- a good example will be the future regime change in Syria if it were to occur. This institutional change will ultimately have an impact on the institutional mechanics and agreements in the region. Syrian opposition has stated many times that future agreements signed by the Bashar el Assad regime will be re-examined and will most likely be re-negotiated, this implies past agreements over transboundary rivers of Syria such as the Orontes River Agreement of 2002 with Lebanon and agreements on the Tigris and Euphrates Rivers with Turkey. A new Syrian regime may wish to halt the construction of the two dams in Lebanon (upstream), including the change in water allocations (currently Lebanon has the right to divert 80 MCM). This will also include the GIS database currently being developed by the two countries and the water rights on the transboundary aquifers of the Orontes Basin.

It is very probable that if a change in regime occurs in Syria, the three co-riparians sharing the Orontes Basin will meet and start new discussions on water allocations. It is likely that Turkey will be more willing to cooperate with the potentially less hostile new Syrian government. In this case, the operation and management of the reservoirs located in Syrian territory will most likely be reviewed and Turkey may wish to obtain more water from the Orontes (see optimization results).

A scenario that can occur is that Turkey enters the negotiations assuming a position against the UN Convention of 1997, similar to what happened during the Union for the Mediterranean Water Strategy when Turkey opposed any allusion to the 1997 UN Convention in the strategy. Ultimately, this would result in a very long negotiation process with the other two riparians and could lead to an institutional conflict that would hinder the creation of a regional transboundary basin organization in charge of managing the watershed.

Unilateral developments can also result from the change in an institutional setting. This includes the construction of dams and internationalization of the issue; in the Orontes Basin three examples illustrate this situation: the interests of Lebanon to construct two dams on the Orontes River (one derivation dam and one storage dam) following the 2002 Syrian-Lebanese Agreement, the bombing of the derivation dam in Lebanon by Israeli forces in 2006 and the desire of the Turkish government to develop additional irrigation projects.

Lebanon may wish to proceed with the construction of the dams ignoring the

position of a new Syrian regime; this will increase the risk of conflict. Also Lebanon is very vulnerable to Israeli attacks, since the first dam constructed on the Orontes (60% complete) was destroyed by Israel during the Hezbollah-Israeli war of July 2006. This attack contributed to the internationalization of the conflict, by introducing a third party (Israel) which does not share the waters of the Orontes River with Syria and Lebanon. It will be interesting to follow the position of Israel in the future, as this hostile act against Lebanon can be seen as a message to the Lebanese authorities which are planning to build a dam on the Hasbani River, a tributary of the Jordan River shared with Israel. Israel may want to warn Lebanon about the consequences of building a dam on its other transboundary river.

On the other hand, unilateral developments in Turkey may also increase the conflict situation, as currently there are 12 development projects in the Orontes Basin in Turkey: 4 are operational, 2 are under construction and 6 are under investigation. The 12 projects will provide irrigation for about 100,000 ha, domestic water supply of 37 MCM/year, hydropower generation (180 GWh/year) and flood protection for 20,000 ha of land (Kibaroglu et al., 2011). Currently, two dams (Tahta Köprü and Yarseli) exist on the Turkish side of the Orontes River in the province of Hatay (Figure 3). The Tahta Köprü dam is used for flood protection, and the Yarseli dam is used for irrigation of 7,300 ha (Tepe et al., 2005).

In terms of environmental and human risks related to water, results demonstrate that Syria is particularly vulnerable to the deterioration of the water security in the basin. The current civil war in Syria can have a direct impact on the water supply to the population living near the Orontes River.

Syria can experience two types of negative impacts on its water resources system: the first impact can come from Lebanon which controls about 400 MCM (0.4 BCM) of the waters upstream. However, this is very unlikely since Lebanon is a relatively water rich and peaceful country and it does not need more than the water allocated according to the 2002 Agreement. This is why Lebanon, which controls only 18% of the waters, was assigned the highest proportion of water allocation in terms of significant harm, since it can potentially cause less harm than the other two countries. Lebanon controls much less water than the other two countries, so theoretically if Lebanon

decides to stop the water from flowing into Syria, it will cause less harm than if Syria stops the water from flowing into Turkey, because Syria controls more flow inside its territory.

Another negative impact could be felt in case the current Syrian regime remains hostile to its population. This regime controls the water resources infrastructure of the country and could deny the 2.5 million Syrians living in the basin access to water from the reservoirs on the Orontes River.

A positive aspect concerning water quality in the basin includes a regional agreement that Turkey, Syria and Lebanon have signed to protect the Mediterranean Sea. The Barcelona Convention for the Protection of the Mediterranean Sea against Pollution entered into force on July 9, 2004. Since the Orontes River, according to the Barcelona Convention, discharges into the Mediterranean Sea in Turkish territory, Turkey confirmed the protection of 12 Specially Protected Areas (SPAs) (Kibaroglu et al., 2005).

5. Discussion and conclusion

The risk analysis and optimization results in the Orontes Basin served as an example of successful transboundary cooperation that is based on the UN Watercourses Convention (UNWC). Negotiations between Lebanon and the Syrian Arab Republic over the waters of the Orontes River have produced the 2002 Agreement, based on the principles of the 1997 UN Convention. The successful application of the 1997 UN Convention in the Orontes Basin may promote positive outcomes between nations and guide riparian states to establish common governance frameworks. Under the current political events, Syria and Lebanon may wish to include Turkey in the negotiation process. This will improve the sustainability of future multilateral agreements. Looking at the evolution of the Syrian-Lebanese transboundary agreements, decision makers in 1994 were involved in a “win-lose” negotiation or zero-sum game since the treaty was signed under Syrian influence, where there was no concern for management of storage and diversion infrastructure. As seen from the optimization results, the 2002 Agreement is considered to be very close to a “win-win” solution or positive-sum game between Lebanon and Syria, since

Participatory hydro-political framework (PHPF) for transboundary basins

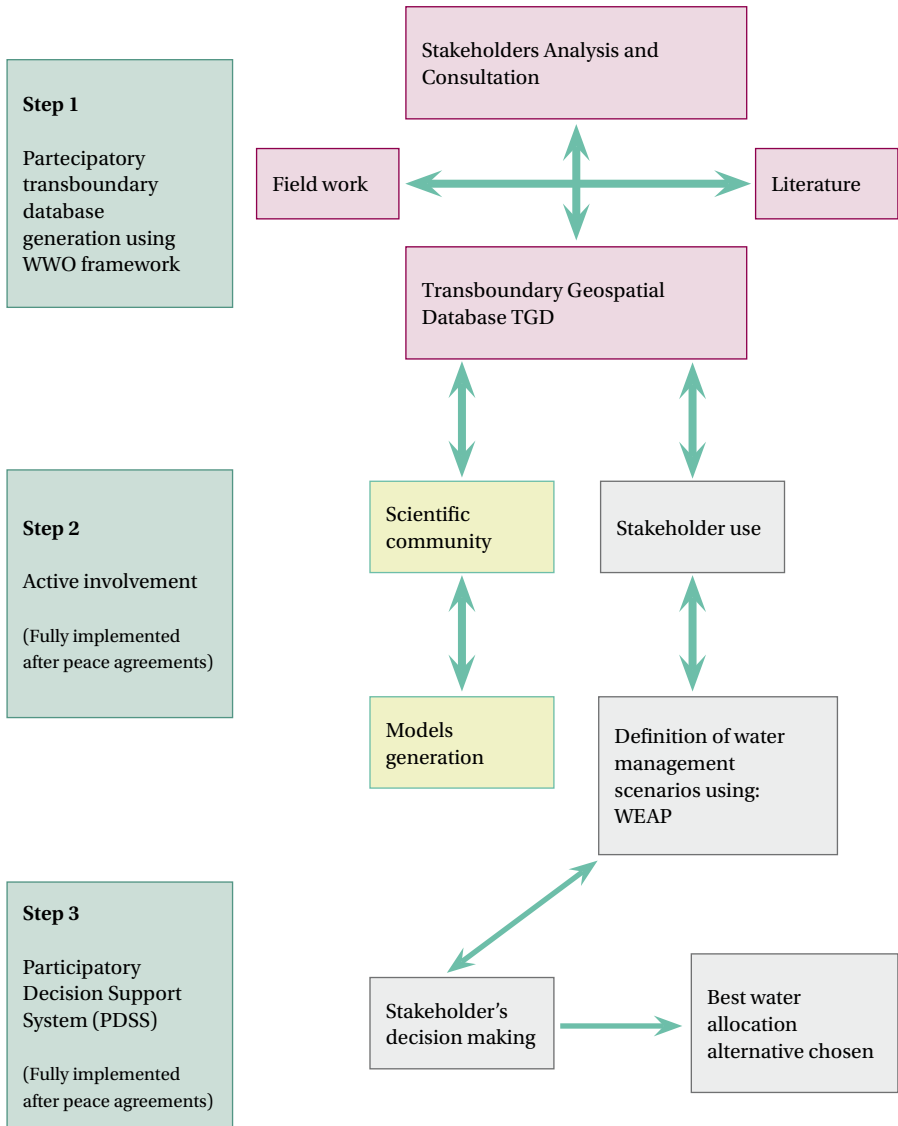


Figure 7: Participatory hydro-political framework (PHPF) for transboundary basins (from: Comair et al., 2014)

the total water (96 MCM/year) allocated to Lebanon (80 MCM from the river and 16 MCM from wells) is very close to the optimized Lebanese share of 27%. However, to arrive at a reasonable agreement that considers the principles of the UN Convention, Turkey should be involved in future negotiations. That is why the importance of the Participatory Hydro-Political Framework (as discussed in Comair et al. 2014; see Figure 7) lies in the participatory approach, as the OWAO method demonstrated that assigning the weights to each factor of the UNWC is subjective and can only be achieved through active participation such as workshops and training.

Currently, only Syria and Lebanon have signed the UN Convention. Results show that Turkey will be interested to join the UN Convention since it is a downstream country of the Orontes River and will thus benefit from an increase in its water rights.

In addition, water information is currently not shared between all co-riparians. Data related to the hydrologic system and water use is still contested between Turkey and Syria. Therefore the LHS can be a useful tool to facilitate water diplomacy and improve sectoral communication in Lebanon by providing usable science and improved knowledge, and the GIS methods are compatible with existing practices in riparian countries such as Lebanon and Jordan. Accessibility to policy makers has been proven by various interactions and meetings conducted with the stakeholders. GIS will help governments standardize the data analysis, thus facilitating the evaluation of different policy alternatives in future negotiations.

References

- CIA (United States Central Intelligence Agency) (2012). Factbook, country profiles: Turkey.
- Comair G.F., McKinney D.C. and Siegel D. (2012). Hydrology of the Jordan River Basin: Watershed Delineation, Precipitation and Evapotranspiration. *Water Resources Management* 26(14): 4281-4293.
- Comair G.F., McKinney D.C., Maidment D.R., Espinoza G., Sangireddy H., Fayad A., Salas F. (2014). Hydrology of the Jordan River Basin: A GIS-Based System to better guide Water Resources Management and Decision Making. *Water Resources Management* 28(4): 933-946.

- CUAHSI (Consortium of Universities for the Advancement of Hydrologic Science, Inc.) (2013). Available at: <http://www.cuahsi.org/>
- DSI (Directorate of State Hydraulic Works) (2002). DSI Tarafından İ letilen ve Devredilen.
- ESCWA (Economic and Social Commission for Western Asia) (2005). Statistical Abstract of the ESCWA Region, Twenty Fifth Issue: E/ESCWA/SCU/2005/7
- FAO (Food and Agricultural Organization) (2003). Syrian agriculture at the crossroads. Report No 8. Available at: <http://www.fao.org/docrep/006/y4890e/y4890e0u.htm>
- FAO (Food and Agricultural Organization) (2008). Irrigation in the Middle East region in figures - Aquastat Survey, FAO water reports.
- Fekete B.M., Vörösmarty C.J., Roads J.O. and Willmott C.J. (2004). Uncertainties in Precipitation and Their Impacts on Runoff Estimates. *Journal of Climate* 17(2): 294.
- Goodall J. L. and Maidment D.R. (2005). A Geotemporal Framework for Hydrologic Analysis. CRWR Online Report 05-8, Center for Research in Water Resources, The University of Texas at Austin. Available at: <http://www.crwr.utexas.edu/reports/pdf/2005/rtp05-08.pdf>
- Horsburgh J.S., Tarboton D.G., Maidment D.R. and Zaslavsky I. (2008). A Relational Model for Environmental and Water Resources Data. *Water Resour. Res.* 44: W05406.
- Kibaroglu A., Klapthake A., Kramer A., Scheumann W., Carius A. (2005). Cooperation on Turkey's transboundary waters. Research report for the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety, Adelphi Research, Berlin.
- Kibaroglu A., Scheumann W. and Kramer A. (2011). Turkey's Water Policy: National Frameworks and International Cooperation, Berlin, Springer.
- Maidment D.R. (2002). Arc Hydro: GIS for water resources, ESRI Press, Redlands, CA.
- Maidment D.R. (2004). Creating Hydrologic Information Systems. Available at: <http://www.ce.utexas.edu/prof/maidment/visual/meetings/utahstate9feb2004.ppt> [accessed 15 January 2004].
- Maidment D.R. (2005). A Data Model for Hydrologic Observations. In CUAHSI Hydrologic Information System Symposium, Austin, Texas, 23 pp.
- Mimi Z.A. and Sawalhi B.I. (2003). A Decision Tool for Allocating the Waters of the Jordan River Basin between All Riparian Parties. *Water Resources Management* 17(6): 447-61.
- NASA/LP DAAC (2011a). ASTER Global DEM Validation Summary Report. Available at: https://igskmncnwb001.cr.usgs.gov/aster/GDEM/Summary_GDEM2_validation_report_final.pdf [accessed 22 October 2011].
- NASA Land Processes Distributed Active Archive Center (LP DAAC) (2011b). ASTER L1B. USGS/Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota. Available at: https://lpdaac.usgs.gov/lpdaac/products/modis_products_table
- SFG (Strategic Foresight Group) (2011). The Blue Peace, Rethinking Middle East Water.
- Tarboton D.G., Maidment D., Zaslavsky I., Ames D., Goodall J., Hooper R.P., Horsburgh J., Valentine D., Whiteaker T. and Schreuders K. (2011). Data Interoperability in the

- Hydrologic Sciences, The CUAHSI Hydrologic Information System. Proceedings of the Environmental Information Management Conference 2011: 132-137. Available at: <http://eim.ecoinformatics.org/eim2011/eim-proceedings-2011/view>
- Tepe Y., Türkmen A., Mutlu E. and Ate A. (2005). Some Physicochemical Characteristics of Yarseli Lake, Hatay, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences* 5: 35-42.
- TSI (Turkish Statistical Institute) (2010). Population of province/district centers and towns/villages and population growth rate by provinces.
- United Nations (UN) Human Development Report (HDR) (2011). Available at: hdr.undp.org/en/reports/global/
- World Bank (2011). World Development Indicators. Gross Domestic Product ranking table. Available at: <http://data.worldbank.org/data-catalog/GDP-ranking-table>



PART III

Lessons learned for future scenarios and challenges beyond the Orontes

Lessons learned for future scenarios and challenges beyond the Orontes

ROBERTA BALLABIO

The overall context of the Orontes River Basin has been presented in the previous sections of this book from different perspectives. It clearly emerges from the different contributions that the basin is characterized by different elements which are strictly intertwined making the context extremely challenging and complex.

Basin level factors to be considered

As already noted in other papers and case studies on transboundary water management (see among others: Jägerskog and Zeitoun, 2009; UN-Water Thematic Paper, 2008; ODI and Arcadis Euroconsult, 2001), shared water resources management embodies many tensions, which are also present in the Orontes case, such as national versus basin interests, long-term versus short-term perspectives, political power priorities versus environmental sustainability needs.

In many cases the main driver of policy and decision making is the aspiration to achieve or maintain internal stability and status quo survival: multiple factors, perceived by each state as their economic, social and political objectives, are considered priorities while water resources, even when shared, are often

seen as a secondary issue. For this reason it is very important to decouple geo-political factors and technical aspects, using the former to improve and inform the latter. The complex hydrography and the transboundary nature of waters make shared management, monitoring, rule enforcement and conflict negotiation particularly demanding: in this framework, technical tools, such as Information and Communication Technology, Geographic Information System, river modeling and specific water related software, can help frame an integrated vision and enhance the development of collective responsibility towards scarce transboundary resources.

This is particularly true for the Orontes River Basin where political drivers and instabilities of the co-riparian countries play a role, but where also a number of other factors will put increased pressure on water resources. The critical factors that will have a direct impact on water availability and quality, or that are already affecting the water resources, are demographic growth, resource degradation and pollution, but they also include climate change, which clearly does not recognize national borders and whose effects are becoming more and more evident.

Multi-stakeholders approach

The multi-stakeholders approach is a widely adopted methodology which implies the inclusion in discussions and negotiations of a wide spectrum of actors, such as policy makers, water experts, institutions, universities and unbiased mediators. This approach has been adopted at national scale in Lebanon by the ICT project *New Technologies for an integrated and sustainable management of natural resources in Lebanon* (referred to as “ICT project”). At a larger scale, including all the riparian states allows for the prioritization of sustainable water management and the elaboration of benefit and cost sharing scenarios within a common framework in order to shape win-win(-win) solutions where water resources are perceived and considered as shared and not divided. This is the essence of hydro-diplomacy.

International legal frameworks, successful river basin models and previous lessons learned can help pave the way for new comprehensive discussions at basin level.

The international cooperation can also play a key role as it can provide a neutral platform, particularly within the United Nations framework, and can endorse steps taken by member states to deal with shared resources. In fact, the Post-2015 Agenda of the United Nations now under discussion includes a set of 17 Sustainable Development Goals (SDGs), where the importance of achieving water security is reflected in one specific SDG: *Ensure availability and sustainable management of water and sanitation for all*. Once agreed by the member states, this Goal will be an integral part of the overall action framework of all UN agencies and programs, boosting the attention on water issues and becoming effective as of January 2016 at least until the 2030 deadline.

Different regional and international actors have developed programs, initiatives and studies, addressing specific cases, thus making it possible to capitalize on accumulated experiences and optimize best practices¹. In particular, programs on transboundary water issues within the UN framework could constitute a suitable framework and a potential tool for sustaining the negotiation process as well as the co-shared sustainable management of common water resources.

An interesting example is the International Hydrological Programme (IHP) of UNESCO which covers a wide range of programs and initiatives at the global and regional level, including scientific and educational issues. Within this framework, it is interesting to mention the PCCP initiative *From Potential Conflict to Cooperation Potential*, active since 2001 as an associated program of the United Nations World Water Assessment Programme (WWAP)². The PCCP program aims to facilitate multi-level and interdisciplinary dialogues in order to foster peace, cooperation and development related to the management of shared water resources and addresses situations where local conditions

¹ To be mentioned among the International Agencies: UNESCO, UNDP, UNEP, UN-Water, Economic Commissions (UNECE, UNESCWA); among the Research Institutions: SIWI, Woodrow Wilson Center; among the initiatives: World Water Week, various projects financed by individual ministries, etc.

² See also: <http://www.unesco.org/new/en/pccp>. The United Nations World Water Assessment Programme (WWAP) is led by UNESCO and coordinates the work of 28 UN-Water members and partners in the World Water Development Report (WWDR). This report is an annual review providing an authoritative picture of the state, use and management of the world's freshwater resources.

could hinder their peaceful and equitable management. PCCP contributes to disseminate best practices of water conflict resolution and cooperation building. A good example of this effort is the Skills-Building Workbook published by UNESCO in 2010.

PCCP was conceived with the central idea of promoting a shift in perspective to foster dialogue and cooperation, providing information, data, tools and skills involving decision makers, water professionals and civil society education sectors, with the aim of facilitating an effective participation in the development of water-related policies. It is in this regard that the ICT project has started to build up a network and to foster exchanges at national Lebanese level, that could be supported by and extended to the other riparian countries.

Scenarios and recommendations originating from the ICT project and the present publication could represent important inputs that could turn out to be useful to increase awareness and efforts across political boundaries in order to start negotiations involving national and regional levels and open up possible roundtable discussions.

One critical aim of water management is to reconcile the opposing interests of all the different water users, especially when they have different national interests. Although transboundary water resources can be potential sources of conflict, their joint management should be strengthened and facilitated as a means of co-operation: PCCP could thus represent a challenge for the Orontes River Basin and create a situation where co-operation potential can emerge. The implementation of this initiative could boost the involvement of key stakeholders at different levels in Lebanon, Syria and Turkey towards building a shared vision for management of water resources based on networking and exchanges.

Starting from data to overcome difficulties

A coherent and complete dataset is still missing for the Orontes River Basin. Data and information are to a certain extent characterized by uncertainty. This state of matter is evidenced by the fact that the different chapters of this book refer to different hydrographical data even regarding the size of the Orontes Basin, the different reach lengths of the river and their distribution

within the riparian countries. Therefore the attempt represented by the ICT project elaborated in collaboration with the Ministry of Energy and Water, involving policy makers and water experts, could constitute an important basis for discussion to increase awareness and knowledge by sharing data and providing modeling training and to plan sustainable water policies. The principles of flexibility and resilience in management need of course to be embedded in this work process according to different scenarios. These can be defined by multiple drivers, such as population, water use, waste and pollution levels, as well as climate change effects. Moreover, the available water quantity can vary in terms of time and space. Climate change makes these shifts even less predictable and has the potential to further complicate existing problems and potentially trigger new instabilities.

Once the current unstable political situation in Syria is overcome, the opportunity to start a new three-pronged negotiation over the shared Orontes River should be taken into strong consideration.

This process will certainly not be free of difficulties and challenges, as experienced during the implementation of the ICT project. Problems can be both substantial and bureaucratic in nature. As far as the first is concerned it is clear that a new approach based on innovative technologies has to be introduced, tailored to the local situation and based on a shared commitment, especially where a traditional field-experience approach is prevailing. Capacity building is therefore a key aspect, so that experts can be made aware of the approach, become familiar with the new tools and capable of exploiting the opportunities they offer.

On the other hand, local dynamics can also play a role, such as decision making and geopolitical dimensions, complex communication flows, conflicts among different stakeholders and particularisms. This is particularly true for areas as the Middle East, where not only internal situations and power asymmetries but also external as well as international contingencies influence progress in the negotiations. This process is accompanied by an increase in complexity as water is becoming scarcer in the region. For this reason, the notion of property rights to water is no longer applicable and should be substituted by the new concept of a shared ownership of water resources through a process that will require time.

Different technical solutions and political and social engagement at different levels can be mutually reinforcing drivers: also small size projects, as the ICT project experience, can contribute to building a new perspective on shared waters and resuming dialogue and exchanges, fostering transboundary relations.

As pointed out by Pohl et al. (2014), a comprehensive approach to move towards improved water management should consider different levels of engagement (national or sub-national, basin, global) and, on the other hand, include different perspectives (financial, legal/institutional, know-how, political especially in terms of capacity development, as well as political coordination).

The ICT project principally addressed capacity building challenging political coordination in a national/sub-national approach focusing on Lebanon.

International cooperation towards institutional and legal support together with capacity building and implementation of initiatives and projects play a central role to pave the way for active engagement and improvement in shared water basins, especially in the Middle East. As water is an essential element for life, it is imperative to consider its shared nature, providing a starting point for genuine cooperation and for fostering diplomacy through scientific cooperation.

As it is important to share successful undertakings, this publication – even though a small scale project – intends to give a contribution to the significant studies and literature on water as a means of cooperation and to show a concrete example of positive synergies contributing to conflict prevention and regional stability.

References

- Jägerskog A. and Zeitoun M. (2009). *Getting Transboundary Water Right: Theory and Practice for Effective Cooperation*, Report No. 25, SIWI, Stockholm.
- ODI and Arcadis Euroconsult (2001). *Transboundary Water Management as an International Public Good*, Prepared for the Ministry of Foreign Affairs, Sweden.
- Pohl B., Carius A., Conca K., Dabelko G.D., Kramer A., Michel D., Schmeier S., Swain A. and Wolf A. (2014). *The Rise of Hydro-Diplomacy*. Strengthening foreign policy for transboundary waters, Adelphi, Berlin.

- UN-Water Thematic Paper (2008). Transboundary Waters: Sharing Benefits, Sharing Responsibilities.
- Wolf A. (2010). Sharing Water, Sharing Benefits: working towards effective transboundary water resources management, UNESCO's International Hydrology Programme, Division of Water Sciences, Paris.

Biographies

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Fadi G. COMAIR graduated from renowned American and French Universities and holds a PhD in Civil Engineering, Hydraulics and Energy Resources. He started his career working with the French Government as a Technical Services Lead at the Ministry of Industry, as well as managing various European Technical Committees related to water and energy resources. Comair was then nominated Chairman of Lebanon's Litani River Authority and subsequently appointed Director General of Hydraulic and Electrical Resources at the Lebanese Ministry of Energy and Water (MEW), as well as Director of the Water, Energy and Environment Research Center (WEERC) and Professor at Notre Dame University. His work at MEW was marked by the initiation of the National Ten-Year IWRM Strategy Plan aimed at satisfying the water demand of the country. He also played an active role in the resolution of conflicts over several transboundary watercourses in the Middle East such as the Orontes, Nahr El Kebir and Jordan River Basins, and published several articles and books on these subjects. Comair is currently Honorary President of MENBO (Mediterranean Network of Basin Organizations) and Vice President of EMWIS (Euro-Mediterranean Information System on know-how in the Water sector). He is also active member of EWRI-ASCE and was awarded the honorary title of Diplomat, Water Resources Engineer (DWRE) by the American Academy of Water Resources Engineers (AAWRE).

Georges COMAIR is currently working at Suez Environnement - Safege in France and has varied experience in water resources modeling, network diagnostic studies, dams and wastewater schemes. He holds a Master and a PhD in Environmental Fluid Mechanics and Hydrology from Stanford University and the University of Texas at Austin. Comair developed water management tools to study vulnerability of water resources in Lebanese transboundary basins. His research interests include the development of national water strategies for Lebanon to ensure the proper management of the Orontes Basin, especially under new negotiations. One area of research, specifically in the upper Jordan River, involved the creation of a GIS database using an Observations Data Model (ODM) with a rainfall runoff model to be used as part of water resources management scenarios.

Bianca DENDENA pursued her academic career at the Faculty of Agriculture of the University of Milan, where she obtained a BSc in Environmental and Land Agritechnology, a MSc in Agri-Environmental Sciences and a PhD in Plant Biology and Crop Production.

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